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WYSS CAMPAIGN FOR NATURE

The Nexus Report: Nature Based Solutions to the Biodiversity and Climate Crisis

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Recommended Citation:

Barber, C.V., R. Petersen, V. Young, B. Mackey, C. Kormos. 2020. *The Nexus Report: Nature Based Solutions to the Biodiversity and Climate Crisis*. F20 Foundations, Campaign for Nature and SEE Foundation.

All dollar ($) amounts specified in this publication are United States dollar amounts.

Foreword

The climate change and biodiversity crises that the world faces are closely intertwined – and they cannot be seen in isolation of a pandemic causing a global 'vulnerability experience of mankind.' The economic impacts of the pandemic will be severe. Stimulus packages are therefore indispensable – but they need to be to be based on sustainability and climate action to increase the resilience of our societies.

The economic crisis offers the opportunity to refocus on sustainable transformation and to develop long-term improvements to our economic, social and political systems. Otherwise, any stimulus will prove to be ineffective in the mid- and long-term, and propel the next global crisis. Be it due to immense environmental pollution, massive degradation of biodiversity leading to grave impacts on global food production, water shortages, energy crises, extreme weather events or everything combined.

In addition to the critical reduction of GHG emissions by moving away from fossil fuels, "nature-based solutions" to emissions reductions in forest and land use, and in the ocean – are crucial. If action on climate change explicitly and systematically takes biodiversity conservation into account, we can generate synergies and positive feedback loops, with respect to generating political will, mobilizing financial and technical resources, and taking action on the ground. Too often, however, biodiversity and climate change are dealt with in relative isolation, including in how governments and other stakeholders organize themselves to act on these two inextricably-linked issues.

This report contains clear policy recommendations for governments to develop effective solutions to climate change and biodiversity loss that are mutually supportive. While the report and its recommendations are tailored to negotiations at COP-15 of the Convention on Biological Diversity (CBD) and the UN Climate Change Conference (COP-26), it is also makes important recommendations to the G-20, bearing in mind that actions by these 20 countries will set the bar for success.

Making the Water-Energy-Food-Health Nexus and the Climate and Biodiversity Nexus an integral part of the G20 agenda is key. Governments should incorporate investments related to these nexus areas in their recovery plans, including sharing best practices and cooperating in international research, especially with regard to the COVID-19 recovery plans. We hope that our list of recommendations in this report can help make recovery plans stronger, and the global approach to the crises we are facing more successful.

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Summary for Policymakers

The climate change and biodiversity crises are intertwined. The loss of biodiversity reduces the resilience of both planet and people and narrows our response options for defeating climate change. Too often, though, biodiversity and climate change are dealt with in relative isolation by governments, intergovernmental processes, and other key actors and stakeholders.

2020 was anticipated to be an environmental "super year", but events took a turn. COVID-19 has put the UN biodiversity, climate and oceans summits on hold but it has not ameliorated the urgency of addressing our global environmental challenges. Indeed, the pandemic has focused attention on the imbalance in humanity's relationship with nature, and on the fragility of the bonds of globalization. The resulting economic crisis has given us an unprecedented chance to build back our economies and societies in ways that restore prosperity and reduce risks of future pandemics while addressing the climate and biodiversity crises. Nature-based solutions (NbS) can and must provide a large part of this integrated response.

NbS must ultimately be implemented through national and local action, but the UN Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD) have critical roles to play in increasing political ambition, setting a course, and mobilizing action. Global crises cannot be solved by individual nations, communities or companies on their own. The private sector, civil society, scientific and educational institutions, and local communities all play key roles, but they do not possess the political power or public financial resources that governments command.

The UNFCCC and CBD are by no means perfect instruments. But given the urgency of our global environmental challenges, we must work with these instruments, and we must do so more effectively than in the past. The members of the G20 – constituting most of the world's people, economic and trade activity, greenhouse gas emissions, biodiversity, and COVID-19 cases – have a critical leadership role to play in making this happen.

This report summarizes the contours of our intertwined global environmental challenges, proposes an integrated strategy for addressing those challenges, and makes recommendations for action in the UNFCCC and the CBD. The report also provides recommendations to the G20 on how it can catalyze and complement action in these conventions and thereby help ensure that COVID-19 response and recovery strategies do in fact "build back better" for both planet and people. The report's main conclusions and key recommendations are summarized below.

Main Conclusions

Nature is under assault. Over 40 percent of the world's land is now agricultural or urban, with only 13 percent of the ocean and 23 percent of the land still classified as intact wilderness ecosystems. Forests, coastal, marine, grassland and freshwater ecosystems have all been reduced and degraded, and the pressure continues to build. The first and most fundamental NbS is thus to slow this assault on nature.

Conserving and restoring nature is critical for achieving the sustainable development agenda. The UN Sustainable Development Goals (SDGs) include goals on climate change and the conservation of biodiversity and ecosystems. These "environmental" SDGs, however, also underpin economic and social SDGs such as food security and the provision of clean air and water. Current trends in biodiversity and ecosystem degradation undermine progress toward achieving 80 percent of the SDGs related to poverty, hunger, health, water, cities, climate, oceans, and land, according to the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES).

Primary forests and coastal ecosystems are the highest priority. These ecosystems play the largest potential role in climate mitigation and adaptation, slowing biodiversity loss, and reducing risk of future zoonotic pandemics. They are also the ecosystems facing the fastest rates of degradation and loss. If we lose these battles, we lose the war.

COVID-19 has demonstrated the cost of imbalances between people and nature. The zoonotic origin of the pandemic has highlighted the consequences of disrupting the balance between human and natural systems. Impacts on human health and the global economy have been devastating, straining public health and financial systems, and throwing social and economic inequalities into sharp relief. Overexploitation of living resources, the fragmentation, degradation and conversion of natural ecosystems – particularly tropical forests – appear to be significant causal factors driving multiplication of these zoonoses. The root causes of zoonotic disease emergence are thus common to the root causes of nature loss.

Meeting global biodiversity, climate and COVID-19 recovery challenges requires NbS. NbS are actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits. Goods and services from nature are worth trillions, and NbS can deliver big economic benefits as well as preserving Earth's basic ecological and atmospheric operating systems. This is increasingly recognized by governments, the private sector, scientists, and economists.

NbS come in many variations, but protection and strengthening of the ecological integrity of natural ecosystems must lie at their core. The closer ecosystems are kept to natural patterns of biodiversity distribution and abundance, the higher the stability and quality of the ecosystem services that they provide. Places that will experience the most severe impacts from global climate change, biodiversity degradation, and the decline of ecosystem integrity are also home to many of the poorest human populations, who disproportionately rely on nature for their livelihoods and are most directly affected by its loss. The loss of ecosystem integrity is thus much more than an ecological issue.

Securing the role of nature in addressing our intertwined global climate, biodiversity, public health, and sustainable development crises requires a three-fold approach: **Protect, restore and connect.** We must *protect* the most biologically-diverse, carbon-dense ecosystems through formal legal designation and other effective conservation and management measures (such as recognition of Indigenous territories); *Restore* the ecological integrity and economic productivity of degraded ecosystems via a broad range of locally-appropriate measures and interventions; and *connect* natural ecosystems across land- and seascapes through both protection and restoration in ways that also maximize synergies across efforts to mitigate and adapt to climate change, halt biodiversity loss, and promote sustainable and equitable development.

Recommendations for the UNFCCC

UNFCCC COP26, scheduled for late 2021, is a pivotal inflection point for progress on climate change. As the UN Secretary General stated in March 2020, "If we are going to limit global heating to 1.5 degrees Celsius, we need to demonstrate, starting this year, how we will achieve emissions reductions of 45% from 2010 levels this decade, and how we will reach net-zero emissions by mid-century."

This report argues, with many others, that there is a very strong case that the necessary level of ambition cannot be reached without robust use of NbS for both climate mitigation and adaptation. As COP26 President Alok Sharma noted in his closing remarks to the Petersburg Climate Dialogue in April 2020, "So many colleagues made comments on the importance of nature based solutions, ensuring that solutions that we have in terms of fixing climate change must integrate nature based solutions….Whatever we do, we [must] have nature based adaptation and biodiversity protection at the heart of our work in tackling climate change."

This can only happen if the Parties at COP26 adopt robust *principles* to elevate the priority of NbS, and concrete *rules and processes* to enable that priority to be turned into meaningful actions.

Principles:

- Reinforce and build on COP25 Decision 1/CP.25, which noted "…the essential contribution of nature to addressing climate change and its impacts and the need to address biodiversity loss and climate change in an integrated manner." COP26 needs to reaffirm, strengthen, and operationalize this important principle.
- Recognize the functional role of biodiversity in maintaining ecosystem integrity and stability as a key principle for UNFCCC operational rules on land use and forests.
- Explicitly recognize the importance and give priority to conserving, restoring, and connecting the most carbon-dense ecosystems, including primary forest, peatlands, mangroves, seagrasses and tidal saltmarshes, as key foundations for climate change mitigation and adaptation.
- Welcome and further develop "alternative policy approaches" (UNFCCC Article 5.2) that link climate mitigation and adaptation via landscape-scale approaches encompassing climate, biodiversity, and socio-economic benefits.

Rules and Processes:

- Recognize carbon "stock accounts" for land and forest ecosystems – in addition to the current focus on carbon flows and fluxes, building on and encouraging ongoing work on this topic under UN System of Environmental and Economic Accounts (UN SEEA).
- Establish a post-COP26 intersessional mechanism to take forward technical and policy work on NbS either under the SBSTA or through constitution of an ad hoc working group.
- Propose, in consultation with the CBD, a process to enhance and facilitate cooperation between the two processes on joint/coordinated action on developing and scaling NbS that at once address the climate and biodiversity crises.

Recommendations for CBD COP15 and the Post-2020 Global Biodiversity Framework

A successful outcome at COP15 will require both adoption of a strong Post-2020 Global Biodiversity Framework and agreement on supporting decisions to enable and empower implementation of the actions called for in the Framework.

The Global Biodiversity Framework should include:

- Explicit recognition of the centrality of conserving and restoring ecosystem integrity to biodiversity conservation, climate change mitigation and adaptation, and the prevention of future zoonotic pandemics.
- A "no loss" goal for the most carbon-dense, high-biodiversity ecosystems with specific targets and timelines, including explicit attention to primary forests, peat forests, mangroves, coral reefs and other coastal ecosystems.
- A goal of including at least 30 percent coverage of Earth's surface *in protected areas and other effective conservation measures* by 2030, with associated targets including specific attention to the most carbon-dense, high-biodiversity ecosystems as specified above.
- A goal that explicitly recognizes the rights of Indigenous Peoples and local communities (IPLCs) and the importance of supporting IPLC territories and conserved areas as an integral part of the Framework and strategy.
- An ecosystem restoration goal focused on rebuilding ecosystem integrity and stability by prioritizing landscape-scale connectivity strategies and initiatives that repair and reconnect natural habitats, improve agroecological practices, and explicitly factor reduction of threat factors for zoonotic pandemics,
- A goal and targets on mobilizing new and expanded finance and other means of implementation to incentivize and mobilize NbS and other measures to achieve all of the goals and targets above.

Supporting COP15 Decisions need to:

- Recognize the importance of NbS for both climate change mitigation and adaptation, affirm the role of the CBD in addressing climate change challenges, and taking a leading role in promoting NbS to address those challenges.
- Establish an intersessional ad hoc Working Group or other process to address development and application of NbS for climate change mitigation and adaptation, as well as for reducing risks of future zoonotic pandemics such as COVID-19.
- Propose, in consultation with the UNFCCC, a process and institutional mechanism to enhance and facilitate cooperation between the two processes on joint/coordinated action on developing and scaling NbS that at once address the climate and biodiversity crises.

Recommendations for the G20

There are three key areas where the G20 can catalyze global political will and mobilize action on the intertwined crises of COVID-19 recovery, climate change, and biodiversity:

- First, the G20 can explicitly reaffirm the principle, found in both UNFCCC and CBD decisions, that the conservation of the most carbon-dense and biodiversity-rich natural ecosystems is a key priority for a raising climate change ambition in the UNFCCC framework, establishing a strong Post-2020 Biodiversity Framework under the CBD, and reducing risks of future zoonotic pandemics.
- Second, the members of the G20 at the Summit-level stand above the negotiating "silos" of the UNFCCC and CBD, and are in a position to send a strong political message on the need for cooperation across the conventions around the adoption and scaling of NbS as a multi-purpose solution for climate mitigation and adaptation, as well as the conservation and sustainable use of biological diversity.
- Finally, the G20 can commit itself to a green and just economic recovery from the COVID-19 pandemic, building win-win NbS into stimulus and recovery packages by committing through its collective agreements and national policies to the following 10 actions:

1. **Avoid relaxation of environmental regulations in the name of COVID-19 stimulus and recovery.** Some governments are relaxing environmental protection and enforcement policies as part of their COVID-19 economic stimulus and recovery packages. This approach is unwise and short-sighted as it provides very limited – if any – emergency economic stimulus and undermines commitments on climate change, nature conservation, the protection of public health, and nature-based tourism development and recovery.

2. **Maintain political space and rights for civil society and the press to serve an effective transparency and monitoring function regarding recovery and stimulus policies.** Some governments have used the pandemic as a pretext to suppress rights of free expression and political

action. While political systems differ across the G20, responsible governments must avoid this tendency and should unite in discouraging such measures by other governments.

3. **Provide income support to reduce the risk of poverty-induced encroachment into nature.** Governments should ensure that safety nets are in place, through social protection schemes (including cash and voucher transfers) targeting the poorest and most vulnerable to food and nutrition insecurity and thus reducing the need for these populations to rely on forests and other natural ecosystems and wildlife for their food security or livelihoods.

4. **Attach green conditionalities to corporate bailouts, especially for sectors with a high impact on nature.** Relevant policy areas include company bailouts, stimulus incentives (e.g., taxation, subsidy, and tariffs), regulation of capital markets, infrastructure investments, and policy and investment priorities for multilateral development banks.

5. **Systematically apply spatial planning across landscapes and seascapes to harmonize nature protection with sustainable economic development**. To be effective, spatial planning needs to engage communities, businesses, local governments, and other stakeholders, be based on the best available science and data, and take place within a clear legal framework that ensures that the process is transparent and that there are accountability mechanisms in place to monitor outcomes.

6. **Repurpose subsidies and other public support towards activities that conserve nature and incentivize NbS to post-pandemic economic recovery and restructuring.** Of more than $700 billion paid in agricultural subsidies each year, only 15% of this support goes towards building public goods. Similarly, $30 billion of public support is poorly targeted at fisheries, with around $22 billion of this classified as harmful. Such subsidy regimes undermine natural capital stocks, endangering biodiversity, long-term job stability, and livelihoods, as well as local and global ecosystem services.

7. **Invest in innovative technologies that will enable more efficient and effective conservation and sustainable use of natural resources.** Recent technological advances now enable near-real time remote monitoring of land use changes to detect and prevent illegal deforestation and encroachment, illegal fishing, mining, and other harmful activities, as well as assist with spatial planning. Materials identification (e.g. DNA and stable isotope analysis) and supply chain logistics technology advances now allow for robust systems to make supply chains more transparent and to enable easier detection of violations and anomalies.

8. **Create an enabling policy environment for private sector investment and innovation, including promotion of market mechanisms to finance NbS.** We are already seeing a significant growth in the interest of private actors in financing "green" and "blue" carbon and other ecosystem services in forests, peatlands, mangroves, and other natural ecosystems. These markets have the potential to scale to billions of dollars of financing for nature over the coming decade.

9. **Invest in human capital, especially young people, to develop the skills and entrepreneurial mindset required to seize opportunities related to a nature-positive economy.** The world young people faced just a year ago was already changing at an unprecedented rate. The pandemic has radically accelerated the pace and direction of change. This young generation will need a substantially new set of skills to confront and adapt to a post-COVID word already reeling from climate change and biodiversity loss.

10. **Mobilize enhanced public international development cooperation to support a just and sustainable economic recovery**. Wealthier "donor countries" are currently preoccupied with their own battle against the coronavirus and its economic impacts, but they should not allow the present crisis to compromise the need for sustained international development assistance to poorer countries who are also grappling with this on top of other long-term challenges. This is not only the right thing to do; it is also in everyone's self-interest, including those in wealthier nations, in our globally interdependent world.

A Call to Action

Whether examined from the perspective of biodiversity, climate change, sustainable development, or human health and well-being, the condition of natural ecosystems is critically important for success or failure in tackling the crises we currently face.

Feedback loops between biodiversity loss and the decline of ecosystem integrity, increasing greenhouse gas emissions, and damage to ecosystem services amplify the crises confronting human well-being and development, including the growing risks of zoonotic disease escaping natural ecosystems and damaging human health. We are witnessing an accelerating downwards spiral for life on Earth.

Reversing this spiral begins with preventing further harm to natural (and mixed agroecological) ecosystems. The next steps require focus on improving and restoring ecosystem integrity and stability at a landscape scale. Ultimate success will depend on developing a new framework for sustainable development – one focused on achieving climate resilient development pathways that deliver positive social and economic outcomes for nature, climate, and communities.

The highest priority for achieving synergistic climate mitigation, adaptation, biodiversity ecosystem integrity, and resilience outcomes at scale is through improving the protection and conservation management of primary forests and other particularly carbon-dense, ecosystems including mangroves and associated coastal habitats, and peatlands.

It's important to understand that natural ecosystems, and in particular primary ecosystems, are irreplaceable for biodiversity and carbon storage in any time frame relevant for reversing the biodiversity and climate crises and certainly by the target dates set for the CBD and UNFCCC of 2030 and 2050.

Encouraging whole-of-government and multi-stakeholder action to tackle the major crises that threaten livelihoods and life on Earth requires new and overarching principles to guide and inform the goals and targets established under the CBD and UNFCCC, especially to guide Nationally Determined Contributions to climate mitigation.

Notwithstanding the current challenging outlook for human well-being, new and exciting opportunities do exist to change the game and establish pathways to integrated solutions to the climate and biodiversity crises that would simultaneously promote climate resilient development and improve the health and well-being of this and future generations.

Introduction

The climate change and biodiversity crises that the world faces are intertwined on land and in the oceans. The changing climate is a growing threat to biodiversity from the Arctic to the Amazon, and the loss of biodiversity reduces the resilience of both planet and people and narrows response options. Too often, though, biodiversity and climate change are dealt with in relative isolation by governments, intergovernmental processes, and other key actors and stakeholders.

The year 2020 was anticipated to be an environmental super year, with major UN summits taking key decisions and catalyzing action on climate change, biodiversity, and the oceans. By March 2020, however, it was clear that the COVID-19 pandemic would postpone the planned summits until 2021. But the issues that the summits are addressing remain urgent and have been given even more significance in light of the pandemic and its impacts.

The pandemic has focused attention on the imbalance in humanity's relationship with nature and on the fragility of the bonds of globalization. The current focus is on the public health emergency and the economic shocks that the pandemic has triggered. In the medium term, attention must also turn to rebuilding our economies and societies in a more resilient manner. Meanwhile, the climate change and biodiversity crises remain urgent, and there is increasing recognition that a durable way forward from the catastrophic events of 2020 must include a robust and integrated response to the intertwined biodiversity, climate, public health, and economic recovery challenges facing humanity.

Political action over the coming year is critical to set in motion needed policy reforms, investments, and actions on the ground. It is also important to develop and hold to a longer-term strategy that addresses both climate change and biodiversity loss. To that end, a group of international organizations have come together to formulate and promote a long-term apex goal on nature (WWF et al. 2020b).[1] On climate, the authors argue, we have a clear goal of carbon neutrality, articulated in the target of zero net emissions by 2050, a milestone of 50 percent reduction by 2030, and a reference target for emission pathways from now until the end of the century. We need a comparable and complementary goal for ecosystems and biodiversity, and the group has proposed the following objective:

> By 2030 there must be at least as much nature on the planet as there is today, and that trend should be heading steeply upwards on a path to full recovery by 2050—with the baseline year of 2020, which can serve as reference for zero net nature loss to ensure that by 2030 we haven't lost further nature and that we have started a process of recovery. This will require us to halt the degradation of healthy ecosystems and to take significant additional action that restores nature and builds the resilience of landscapes and seascapes. By 2050, we will have full recovery and restoration. At this point, we will have achieved sufficient functioning ecosystems to support future generations of people and help avoid dangerous climate change (WWF 2020b).

This report argues that nature-based solutions (NbS)[2] can and must provide a large part of the integrated response to achieving that vision:

- With respect to climate change, reductions in GHG emissions must come largely from reducing use of fossil fuels. But NbS on both land and at sea are critical for reducing greenhouse gas (GHG) emissions as well as for effective climate-change adaptation and resilience strategies.
- To reduce risk of future zoonotic pandemics, NbS are critical for controlling the upstream risks arising from natural forest fragmentation and clearing, as well as the downstream risks of zoonotic spillover arising from the unregulated and often illegal hunting, butchering, handling, and consumption of wild meat.
- For the broader sustainable development agenda, it appears virtually impossible to achieve many, if not most, of the UN Sustainable Development Goals (SDGs) without a far stronger effort to protect, connect and restore natural ecosystems and the services and benefits that they provide.
- Biodiversity underlies NbS, of course, but a stronger reliance on NbS to solve climate, health, and development challenges will also demonstrate the value of biodiversity and critical ecosystems and provide tangible reasons to conserve them.

Although all natural and modified ecosystems can play a role in mobilizing NbS, we focus in this report on two ecosystems that we believe are most critical for developing and implementing NbS at a broad global scale: the planet's remaining natural forests, particularly primary forests, and the ocean, specifically nearshore and coastal zones. We concentrate on these ecosystems for the following reasons:

1. They harbor the great majority of the planet's biodiversity;
2. They are the natural ecosystems most important for climate change mitigation and adaptation;
3. They are among the ecosystems most threatened by anthropogenic pressures; and
4. The conservation and sustainable use of oceans and forests constitutes a key foundation for achieving most if not all of the SDGs.[3]

NbS must ultimately be implemented through national and local action that enlists and mobilizes multiple stakeholders. This report focuses, however, on the need for strong international government leadership and cooperation working through established intergovernmental mechanisms, in particular the UN Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD). We adopt this focus for three reasons:

- **International cooperation is essential.** The intertwined challenges that constitute the present global crises cannot be solved by individual nations, cities, or communities on their own.
- **Only governments, working together, can provide the catalyst and framework for action at the necessary scale.** The private sector, civil society, the scientific and educational institutions, local communities, and other actors and sectors play critical roles. However, they cannot and should not replace the role of government in public policy and cannot mobilize the force of law and public financing that governments can.
- **The challenges of climate, biodiversity, human health, and development that we face are urgent.** Our existing intergovernmental institutions are by no means perfect, but we do not have the luxury of reinventing them before we take action. We must work quickly with the tools we have in hand, and the three highest priority opportunities for intergovernmental action in the coming two years lie with the CBD, the UNFCCC, and the G20.

The report is intended to serve as an anchor and resource for efforts to ensure that NbS become a major part of synergistic post-2020 intergovernmental action on climate-change mitigation and adaptation, biodiversity conservation and sustainable development. The global public health and economic crises brought on by the COVID-19 pandemic provide further rationale and urgency for action on NbS, and the report's analysis and recommendations reflect these unique circumstances facing the world in 2020.

The report does not address every aspect of climate change, biodiversity, or the health, economic, and political dimensions of the COVID-19 pandemic and its impacts. Rather, it focuses on the nexus of those three global challenges where conserving biodiversity and maintaining the ecological integrity of natural ecosystems can provide strategies and solutions to meet these intertwined challenges.

Box 1. Key Opportunities to Catalyze International Action 2020–2022

CBD COP 15. China is slated to host the 15th Conference of the Parties (COP15) to the CBD during the latter part of 2021. COP15 is expected to result in a negotiated Post-2020 Biodiversity Framework as successor to the 2010 CBD Aichi Targets. This is a critical opportunity to put NbS in place as part of the international framework for global environmental action to 2030 and beyond. COP 15 will build on the outcomes of the 2019 UN Climate Action Summit (UNCAS), which included a Nature-Based Solutions Track co-chaired by China and New Zealand, as well as the September 2020 UN Biodiversity Summit, which was held as part of the 75th anniversary session of the UN General Assembly.

UNFCCC COP 26. In November 2021, the United Kingdom will host the 26th Conference of the Parties (COP 26) to the UNFCCC, a key inflection point in efforts to further implement the landmark 2015 Paris Climate Agreement. The UK has stressed that one of its objectives as COP 26 president is to maximize the potential of nature-based solutions to enhance prosperity, reduce emissions, and safeguard resilience. This builds on the outcomes of COP 25, held in Madrid in 2019, which, in its Decision 1/CP.25 on ambition underlined "the essential contribution of nature to addressing climate change and its impacts and the need to address biodiversity loss and climate change in an integrated manner."

The G20. In November 2020, the Kingdom of Saudi Arabia (KSA) will host the annual meeting of the G20, the members of which collectively represent some 80 percent of world trade and 90 percent of world GDP. The G20 played a significant role in making the 2015 Paris Climate Agreement possible, but since 2016 has not engaged in climate change or other global environmental challenges due to opposition from a few member states, most prominently the United States. For 2020, however, KSA, as G20 president and host of the summit, has laid out three principal aims, one of which is "safeguarding the planet by fostering collective efforts to protect our global commons. This includes advancing synergies between adaptation and mitigation efforts to tackle climate change, protecting the environment by taking concrete actions, promoting cleaner and more sustainable energy systems and affordable energy access, promoting water sustainability, and reducing food loss and waste" (KSA 2019). Italy will host the G20 in 2021 and is likely to continue a focus on climate change, biodiversity, and green economic recovery as part of the agenda.

Stockholm+50. Looking to 2022, a major international summit on global environmental challenges is being discussed within the United Nations Environment Programme (UNEP) to mark the 50th anniversary of the 1972 Stockholm Conference on the Human Environment and the 30th anniversary of the 1992 UN Conference on Environment and Development, also known as the Earth Summit (UNEP 2018). The policy rationale is the need to encourage greater confluence and synergies among the Rio Conventions (UNFCCC, CBD, and the UN Convention to Combat Desertification) in the context of achieving the SDGs. The practical rationale for such a gathering arises from continuing uncertainty about the status and impacts of the COVID-19 pandemic on scheduled events during 2021.

Nature in Crisis and Nature as a Solution

2.1 Nature under assault

More than ever, we need nature to address the intertwined challenges of combating climate change and biodiversity loss, achieving the SDGs, and rebuilding resiliently from the COVID-19 pandemic. But nature is under continued assault.

Over 40 percent of the world's land is now agricultural or urban, with ecosystem processes deliberately redirected from natural to anthropogenic pathways. Human drivers extend so widely beyond these areas that as little as 13 percent of the ocean and 23 percent of the land can still classified as being "intact ecosystems" (Watson et al. 2018a). The most accessible and hospitable biomes either have been almost totally modified by humans in most regions (e.g., Mediterranean forests and scrub and temperate forests) or show maximum levels of conversion to anthropogenic biomes (e.g., conversion of most temperate grassland to cultivated land and urban areas).

Freshwater and many marine ecosystems are also under severe threat (Brondizio et al. 2019). Carbon-dense coastal and nearshore ecosystems, such as mangroves, seagrass beds, and salt marshes, are well below natural baseline levels for biodiversity, ecosystem integrity, and carbon storage and declining rapidly. Declines in these ecosystems have a direct effect on climate mitigation and adaptation, disaster risk reduction, and food production for millions of people (Hoegh-Guldberg et al. 2019.). Tropical coral reefs, home to the vast majority of documented marine species, have suffered major declines from direct human exploitation, land-based sources of pollution, and the impacts of climate change, including warming ocean temperatures and ocean acidification (Heron et al. 2017.)

While the extent of protected areas has significantly increased in line with the CBD Aichi targets during the 2010–2020 UN Decade of Biodiversity (Visconti et al. 2019), the impact pales in comparison to the escalating pressure from development:

- Globally, areas of intact natural ecosystems fell by one-tenth from 1993 to 2009 (Watson et al. 2018a), with areas in the tropics suitable for agriculture declining the fastest (Venter et al. 2016).
- Forests fragmentation is reaching critical thresholds (Taubert et al. 2018), with 70 percent of forests now less than 1 km from a forest edge (Haddad et al. 2015), and natural ecosystems fragmented into some 600,000 pieces, according to one estimate (Ibisch et al. 2017).
- Half of the world's identified biodiversity hotspots have just 3–10 percent intact vegetation remaining (Sloan et al. 2014).

The need for action is urgent. Some scientists warn that Earth is approaching dangerous tipping points in our planetary system (Steffen et al. 2015). In practical terms this means that many systemic changes will be difficult, costly, or impossible to reverse. These ecological tipping points could have unknown social costs and precipitate a cascade of damages, as we have recently seen with sharp global increases in catastrophic wildfires (Lindsey 2020; Pierre-Louis 2019).

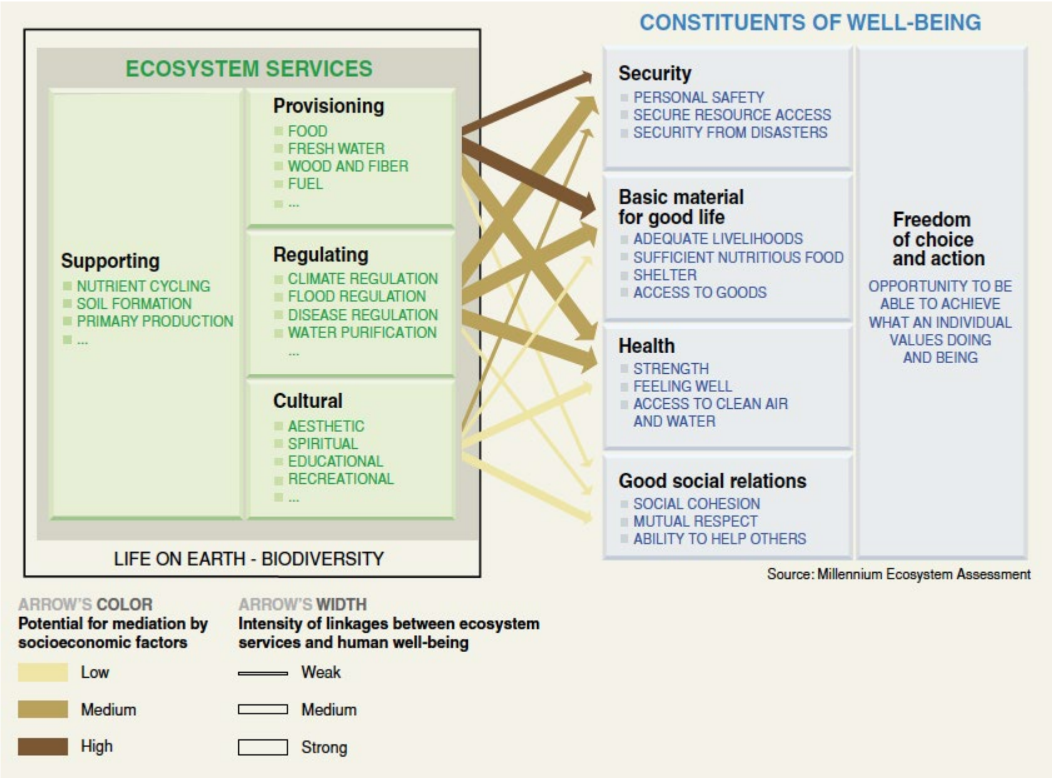
In the Amazon, scientists predict that continued deforestation, mostly for large-scale industrial agriculture expansion, may cause the ecosystem to rapidly convert from tropical forest into savannahs, due to decreased moisture in the hydrological cycle (Lovejoy and Nobre 2019). Such an event would not only result in a sudden decline in biodiversity and release mass amounts of carbon, but also importantly disturb the regional water supply, potentially affecting local farmers and the millions living in nearby cities who rely on tropical forest biomes to provide a stable water supply.

The first and most-important NbS is thus to slow this relentless assault on nature.

2.2 Why nature matters for the sustainable development agenda

The UN 2030 Agenda for Sustainable Development outlines an integrated global agenda for people, planet, and prosperity. Agreed by the United Nations in 2015, its 17 SDGs and associated targets aim to eradicate poverty and achieve sustainable development by 2030 while protecting the global environment and ensuring that no one is left behind. Global environmental challenges are directly addressed in Goal 13 (Climate Change), Goal 14 (Life below Water), and Goal 15 (Life on Land).

Figure 1. Ecosystem Services and Their Benefits for Humanity



Source: Millennium Ecosystem Assessment.

These environmentally focused SDGs, however, underpin other goals because, for example, healthy ecosystems contribute to food security (Goal 2) and provide clean air, water, and ingredients for modern medicine (Goal 3). Overall, ecosystem services like the provision of water, habitat and biodiversity maintenance, and carbon sequestration contribute to more than 14 SDG targets, with significant synergies across multiple SDGs (Wood 2018). Current trends in biodiversity and ecosystem degradation undermine progress toward achieving 80 percent of the SDGs related to poverty, hunger, health, water, cities, climate, oceans, and land (Brondizio et al. 2019).

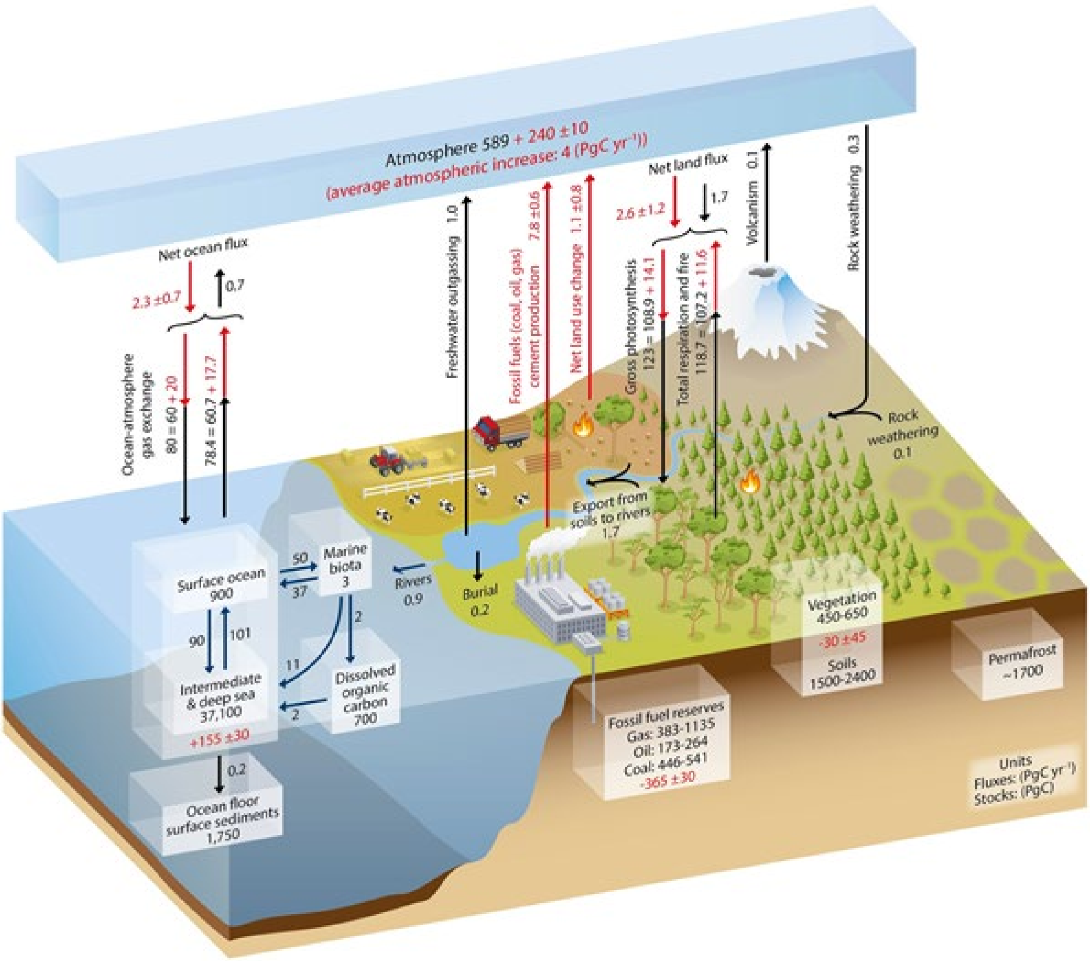
It is clear that halting biodiversity and climate change are essential to achieving many of the SDGs. But it is also critical to ensure that the pursuit of the more social and economic-focused SDGs does not exceed the key planetary boundaries (Rockstrom et al. 2009) that shape and limit the human prospect. Recent analyses show that this is possible, but not without transformational changes in our modes of economic production, trade, and consumption. "Nowhere . . . is it admitted in the 2030 Agenda that the successes in reaching the eleven social and economic goals (Goals 1–11), if done based on conventional growth policies, would make it virtually impossible to reduce the speed of global warming, to stop overfishing in the oceans or to stop land degradation, let alone to halt biodiversity loss" (Randers et al. 2018).

We are thus at a critical juncture where recognizing the scale and urgency of the climate and biodiversity crises and taking action based on the linkages between them has become critical to humanity's continued well-being and even survival. Most fundamentally, because climate change is a threat multiplier," its impacts—extreme weather events, droughts, food shortages, and associated political instability—threaten to undo progress on *all* SDGs. Simply put, healthy ecosystems underpin human prosperity; a degraded planet impedes progress toward the 2030 Agenda (IUCN 2020a).

Teasing out the linkages between the climate and biodiversity crises reveals a spiral relationship in which each crisis amplifies the other. As illustrated in Figure 2, more carbon is stored in natural ecosystems than in known reserves of fossil fuels (Mackey et al. 2013).

Addressing drivers that increase the risk of premature release of ecosystem carbon stocks to the atmosphere is therefore critically important for success or failure in limiting warming to as close as possible to 1.5°C. Damage to ecosystems reduces their stability and increases premature release of GHGs to the atmosphere, thereby raising global temperatures, which, in turn, increases the likelihood of damage to ecosystems from pests, disease, drought, and fire. The greater the damage to ecosystems, the greater the actual and future likelihood of premature release of carbon into the atmosphere.

Figure 2. Simplified Schematic of the Global Carbon Cycle



Source: Clais et al. 2013.

2.3 COVID-19: Humanity and nature out of balance

During 2020, the world was sharply reminded of the consequences of the gross imbalances in the relationship between people and nature. In the words of a group of top global experts, "there is a single species that is responsible for the COVID-19 pandemic—us. As with the climate and biodiversity crises, recent pandemics are a direct consequence of human activity—particularly our global financial and economic systems, based on a limited paradigm that prizes economic growth at any cost" (Settele et al. 2020).

More than 70 percent of emerging zoonoses (infectious diseases that are transmitted from animals to humans) originate in wildlife, and the rapid, global spread and impacts of COVID-19 have dramatically illustrated humanity's vulnerability to such pandemics (Plowright et al. 2020). The impacts on human health and the global economy have been devastating, straining public health and financial systems to the point of breaking and throwing social and economic inequalities into sharp relief.

The zoonotic origin of the coronavirus has highlighted the consequences of disruption in the balance and linkages between human and natural systems, as well as the serious risk posed by commercial markets and trade in wildlife for human consumption. COVID-19 is not the first of these emerging infectious diseases, nor is it likely to be the last.

Reviews of the science suggest that anthropogenic pressures on biodiversity—in particular, the overexploitation of living resources (including poaching), the fragmentation and rapid reduction of natural habitats (which generate collapse of animal and plant populations in many taxa), and a significant loss of genetic and phylogenetic diversity—are probably significant factors driving multiplication of these zoonoses (Settele et al. 2020; Soubelet et al. 2020). Zoonotic EID risk appears to be particularly elevated in forested tropical regions experiencing land-use changes and where wildlife biodiversity (mammal species richness) is high (Allen et al. 2017). Climate change exacerbates these risks and has, for example, facilitated an increase in the distribution of disease vectors such as the mosquito due to climate-induced changes in species ranges and biodiversity distribution (Pecl et al. 2017).

The pandemic has hit a world already facing a planetary emergency due to climate change, the degradation of natural ecosystems, and the accelerating loss of biodiversity. With 1 million species at risk of extinction, we are losing the natural environment at an unprecedented rate and experiencing a sixth mass extinction of species (Ceballos et al. 2020), while the planet is currently warming at alarming rates (IPCC 2018). The nature and climate crises not only reinforce each other, they exacerbate other crises for human well-being including poverty, inequality, illness, and hunger (IPCC 2019; Brondizio et al. 2019.)

Science tells us that a healthy planet is critical to our ability to rebound from the COVID-19 pandemic and to prevent future zoonotic diseases. The deterioration of ecosystems and the biodiversity that underpins them from habitat loss and modification, agricultural development, climate change, pollution, and overexploitation of species is increasing the risk of zoonotic pandemics (UNEP 2020; Evans et al. 2020). The root causes of zoonotic disease exposure are common to some of the root causes of nature loss and require an integrated approach (WWF 2020a, 2020b).

Given the roots of the current pandemic in imbalances in the relationship of people to nature, it is crucial that economic recovery measures do not make these imbalances worse and thereby increase the risk of future pandemics and disruptions (Quinney 2020). COVID-19 has exposed key fractures and weaknesses in our economies and societies (WEF 2020a). Social and cultural inequalities have been laid bare, with the poor and disempowered minorities suffering disproportionately from effects of the virus. Wildlife trafficking and illegal logging have surged in some places as criminals take advantage of the policy and enforcement vacuum brought on by the crisis on the frontiers of natural ecosystems.

At the same time, the Covid-19 crisis presents an unprecedented chance to bring about the transformative changes identified by the IPCC, IPBES, and others to catalyze integrated policy and action on biodiversity, climate change, and the sustainable development agenda. In total, US$11.5 trillion has already been earmarked for COVID-19 stimulus packages globally, and trillions more will be present over the long recovery period before us (WEF 2020c). Never before have governments put so much money on the table to stabilize and revive the economy. Done in the right way, this vast investment portfolio can stimulate a passage to a better model of sustainable economic growth and development that at once slows biodiversity loss, reduces climate change, and restores prosperity and security for humanity (Cook and Taylor 2020; WEF 2020c).

But it is not inevitable that this once-in-a-generation opportunity will turn the world away from unsustainable business-as-usual. As the World Economic Forum (2020a) warns, “As countries start to emerge from the immediate health crisis and work on rebooting their economies, potential divergent trends on the role of sustainability in those efforts create emerging risks of a slowing or multi-speed transition of economies and industries.”

On the one hand, we hear calls for green stimulus and recovery measures from many leaders and we see some changes in production models and consumer behaviors that may support the sustainability agenda. On the other hand, we see others doubling down on business-as-usual environmentally-destructive stimulus measures, cuts in sustainability investments, and weakening of commitments to climate and nature action in the name of responding to the pandemic emergency.

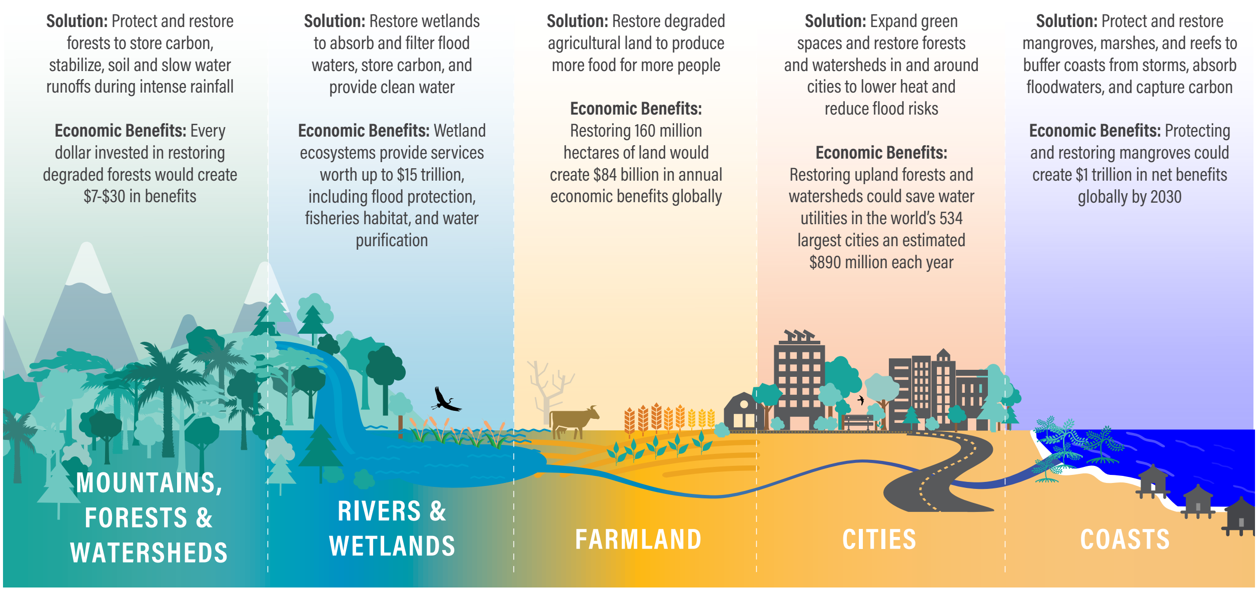
It is crucial therefore, that leaders who desire a green recovery and a sustainable future take a strong stand over the coming months and years. In particular, they need to lead the world in mobilizing NbS on a scale never seen before, in partnership with business, science, and civil society.

2.4 Nature-based solutions: “No regrets” strategies for people and planet

Due to their potential to deliver on multiple climate, biodiversity, and human health benefits, there is growing recognition about the importance of NbS within international policy processes, civil society campaigns, and private-sector initiatives. For example, NbS were endorsed by both IPBES (Brondizio et al. 2019) and the IPCC (2019) and highlighted at the September 2019 UN Climate Action Summit (United Nations 2019). More than 66 percent of submissions on Nationally Determined Contributions (NDCs) under the UNFCCC process include mention of NbS to achieve the Parties’ climate mitigation and/or adaptation targets (Seddon et al. 2020).

The term *nature-based solutions* was first developed during the UNFCCC negotiations in 2009 and was formally defined by IUCN’s membership at the 2016 World Conservation Congress as “actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.” In 2020, IUCN published its Global Standard for Nature-based Solutions (IUCN 2020b) after several years of consultation and this report applies this definition, with the caveat that NbS is still an evolving concept that will require greater clarity with respect its concepts and elements for acceptance and implementation at scale.

Figure 3. Nature-Based Solutions Can Deliver Big Economic Benefits



Source: WRI 2019.

Nature underpins economies and society on many levels. Ecosystem services worldwide are worth an estimated $125 trillion annually, and they support industries like farming, fishing, forestry, and tourism that employ 1.2 billion people (Cook and Taylor 2020). A recent World Economic Forum report (WEF 2020b) estimates that more than half of the world's GDP is moderately or highly dependent on nature and its services. About 1.6 billion people rely directly on the world's forests for food, income, and livelihoods. Healthy ecosystems also enhance humanity's resilience to future shocks by strengthening food security, protecting us from climate impacts, mitigating climate change, and improving our health (Cook and Taylor 2020).

NbS can deliver big economic benefits (see Figure 3). A major recent study (Waldron et al. 2020) has found that protecting at least 30 percent of the world's land and ocean would require an average annual investment to 2030 of $140 billion, which is less than one-third of the government subsidies currently directed to activities that destroy nature. This investment would mean short-term net costs, but they would be offset by financial benefit over time, providing financial outcomes and nonmonetary benefits (e.g., tangible ecosystem services) that would exceed the costs by a factor of at least five to one.

Conversely, there is increasing recognition by the business community that degradation of nature poses a material risk to business operations. For the first time in 2020, the top five global risks identified by the World Economic Forum's Global Risks Report all relate to the environment, with global biodiversity loss and climate ranking at the top (WEF 2020d). The private-sector community increasingly understands that investing in nature is good for business.

Despite this attention, investments in NbS remain relatively small, especially in comparison to subsidies and other fiscal policy going directly to efforts that threaten nature. As summarized by the Interim Dasgupta Review commissioned by the UK Government (Dasgupta et al. 2020), government subsidies for exploiting nature are conservatively estimated to be between $4 and $6 trillion globally per year for agriculture, fossil fuels, and water (OECD 2019; Coady et al. 2019). Another major study (Pharo et al. 2019) found that the majority of the $700 billion in global farm subsidies promotes land conversion or pollution from the overuse of fertilizers, with only 1 percent allocated toward environmental protection measures.

These figures dwarf the amount flowing to NbS—only 5 percent of climate finance—and to conservation and restoration of the biosphere. And while the private sector increasingly invests in climate mitigation such as renewable energy technologies, there is still too little investment into the protection or regeneration of natural carbon sinks. Increased public financing for NbS is therefore critical. Domestic public finance for biodiversity-related activities was $67.8 billion per year on average between 2015 and 2017 (OECD 2019). Estimates of wider finance flows to biodiversity (for example, from economic instruments, philanthropy, and impact investing) are between $10.2 billion and $23.2 billion per year (OECD 2019), a fraction of what is needed.

Box 2. Nature-Based Solutions: Points of Controversy

Some critics reject NbS on ideological grounds. Others caution that, if poorly implemented, NbS could produce perverse outcomes for humans and ecosystems and fail to lead to verifiable emissions reductions. And some decry the adoption of NbS rhetoric by forestry, industrial agriculture, and fossil fuel companies as greenwash for continuing business-as-usual practices. Critiques include the following arguments:

- NbS create a moral hazard: Some researchers and civil society groups fear the current NbS discourse reduces the imperative to rapidly transition high emitting sectors like energy and transport. They warn that NbS should not replace needed reductions in other sectors but be used as a way to compensate for especially hard-to-decarbonize sectors like aviation and manufacturing. (Anderson et al. 2019).
- NbS commodify nature: Indigenous and environmental groups argue that nature should never be privatized and commodified through market-based mechanisms like forest carbon offset schemes. Valuing the carbon stored in natural ecosystems risks land grabs and widespread infringements of local community and Indigenous rights, a criticism that has roots in early concerns about REDD+.
- NbS may impose a "tyranny of trees": Widespread enthusiasm for reforestation and afforestation, as exemplified in the One Trillion Trees Initiative, may encourage large-scale monoculture and nonnative tree plantations, which threaten biodiversity and do not store as much carbon as natural species. In addition, researchers point out that global models overestimate the potential for reforestation and afforestation by misidentifying natural grasslands as areas of opportunity for tree growing. A myopic focus on climate benefits creates a "tyranny of trees" mentality that overlooks the crucial biodiversity, carbon, and other values of other natural, non-forested ecosystems like as grasslands. (Veldman et al. 2015a, 2015b).
- NbS rhetoric has been co-opted by wood-based industrial interests to justify business-as-usual practices: The logging industry has begun to use NbS language to justify continued industrial-scale logging of intact primary forests, despite strong evidence that this is antithetical to climate and biodiversity goals. Bioenergy has also been touted as an NbS, although biofuels rely on industrial production of crops and bioenergy requires massive monoculture tree plantations, both of which can threaten native ecosystems and increase competition for land, leading to food insecurity. Some scientists argue that substituting biofuels for gasoline will in fact increase GHG emissions when analyses consider emissions from the conversion of forest and grassland to industrial cropland (Searchinger et al. 2008).

While IUCN's effort to establish a science-based standard to determine what counts as legitimate NBS are welcome, the reality is that the term NbS has "escaped the lab" and is widely used - and sometimes misused – as a catchall phrase encompassing a host of approaches and projects purporting to be related to nature in some way. As a result, both the theory and practice of NbS has generated criticism (see Box 2).

Critiques aside, NbS do indeed come in many shapes and forms and are being applied to climate-change mitigation, climate-change adaptation, biodiversity conservation, and various aspects of economic and human development:

- **NbS for climate mitigation:** Natural climate solutions (NCS), a subset of NbS, focus on protecting, managing, or restoring ecosystems with the primary goal of mitigating GHG emissions or increasing carbon sinks in the landscape. Recent estimates suggest that just 20 NCS could provide over one-third of cost-effective mitigation needed by 2030 to keep global warming below 2 degrees (Griscom et al. 2017). Many of these NCS opportunities are more cost-effective than emerging negative emissions technologies, such as bioenergy with carbon capture and storage (BECCS). A follow-on study found that NCS could reduce greater than 50 percent of national GHG emissions in 38 tropical countries and greater than 100 percent in 23 countries. This means that countries like Costa Rica, Liberia, and Kenya could become carbon neutral or net carbon negative through wide-scale implementation of efforts to reduce ecosystems-based emissions and increase carbon sinks in the land (Griscom et al. 2019). Indeed, Costa Rica has adopted a plan to completely decarbonize its economy by 2050, fully integrating NbS and biodiversity-positive outcomes into its plan (see Box 3).

- **NbS for climate adaptation:** NbS also play a vital role in adapting to climate change and creating more resilient communities. The Global Commission on Adaptation identified NbS as cost-effective climate resilience strategies and called for large-scale, coordinated approaches to their financing and implementation. Notably, many NbS that are cost-effective for climate mitigation can also support adaptation. For example, protecting

Box 3. Costa Rica's National Decarbonization Plan 2018–2050

For decades, Costa Rica has been known as a leader in conserving its biodiversity and natural resources and promoting sustainable development, including achieving an almost emissions-free electricity grid, very low rates of deforestation, a strong protected areas network, significant progress in restoration of degraded forest lands, and pioneering one of the world's first payment-for-ecosystem-services systems. Now, Costa Rica has committed to becoming a decarbonized economy with net zero emissions by 2050 and has put in place a detailed plan to achieve this goal. In his inaugural speech in 2018, President Carlos Alvarado said, "[D]ecarbonization is the greatest mission of our generation, and Costa Rica must be among the first countries of the world to achieve it, if not the first."

While most of the NDCs under the Paris Agreement propose emissions reductions that are not up to the climate challenge, Costa Rica has committed itself to a goal consistent with the agreement's decarbonization objectives. Costa Rica has thus become a decarbonization laboratory for the world to reinforce what has been learned to date and to progress in areas where others seek innovative examples.

Costa Rica recognizes that the path to decarbonization cannot be achieved through incremental adjustments; it requires substantial technological, institutional, and economic changes. The plan also recognizes that while NbS are an important tool, the most critical emissions-reduction measures lie in the energy and transport sectors and that changes in those sectors will need to be carried out with technologies different from the ones currently in use.

Planning decarbonization involves every sector of the economy. The plan is therefore structured along 10 decarbonization axes derived from the pattern of the country's GHG emissions. The axes correspond with the four major emission sources: energy (transportation-collective, private and freight, electric system, residential and commercial sector and industrial sector); industrial processes; waste and recycling (residues); and agriculture, forestry, and other land uses (cattle, agriculture, and forests).

Axis 10 states that "the management of the rural, urban and coastal territory will be oriented toward conservation and sustainable use, growing forestry resources and ecosystem services based on nature-based solutions," and lays out the following "transformation vision":

- By 2030, the current forest cover is maintained, and new areas are restored to increase the cover to 60 percent, without competing with the agricultural sector.
- By 2050, 4,500 hectares of green areas operate as recreational parks in the San Jose Greater Metropolitan Area (the country's largest population center), and a system of environmental-pedestrian networks that act as both biological and pedestrian corridors is consolidated.
- By 2050, the rural and coastal landscape allows the restoration and protection of other high-carbon ecosystems (mangroves, wetlands, peatlands, soils).

Source: National Decarbonization Plan 2018–2050, Government of Costa Rica.

mangrove forests provides more than $80 billion a year in avoided losses from coastal flooding, protecting 18 million people, while also contributing $40–50 billion per year in nonmarket benefits related to forestry, fisheries, and recreation. The benefits from mangrove protection and restoration are up to 10 times the costs (GCA 2019).

- **NbS for biodiversity conservation:** By and large, the same places that are critical to reverse the loss of biodiversity are the same as those needed to achieve climate mitigation and adaptation goals. A recent study identified 54 percent of the terrestrial realm which, if conserved, would reverse further biodiversity loss, enhance carbon removal, and prevent CO_2 emissions—an amount of land in line with recent calls to preserve half of nature on Earth (Wilson 2016). However, researchers point out that, in order to support biodiversity, NbS focused on protecting and restoring habitat should consider connectivity through establishing wildlife corridors, which offer multiple benefits to wide-ranging species and allow for shifting climate envelopes (Dinnerstein et al. In Press).

Box 4. Ecosystem Integrity: The Linchpin for Climate, Biodiversity and Sustainable Development

Responding to this dire situation requires a priority policy focus on maintaining and restoring ecosystem integrity. The integrity of an ecosystem can be understood as its naturalness or absence of significant human disturbance and has been defined as “the ability of an ecological system to support and maintain a community of organisms that has species composition, diversity, and functional organization comparable to those of natural habitats within a region” (Parrish et al. 2003).

Nature provides many biodiversity and ecosystem functions and services critical to healthy human life on Earth. These include breathable air, potable water, fertile soils, pollination and pest control, bountiful seas, and a stable climate (Brondizio et al. 2019; Reid et al. 2005). The closer to natural patterns of distribution and abundance of biodiversity within ecosystems and the greater their integrity and stability, the higher the quality of ecosystem services that they provide and the more secure their carbon sequestration and storage.

However, the world faces a decline in ecosystem integrity at rates unprecedented in human history. The latest IPBES report found that human activity threatens more species with extinction than ever before, with 25 percent of species—around 1 million—threatened with extinction (Brondizio et al. 2019). The primary drivers of this loss, IPBES found, include changes in land and sea use and direct exploitation of animal and plant life, as well as climate change and pollution. Seventy-five percent of the land surface has been significantly altered while 66 percent of the ocean area has been affected by human activity, including live coral reefs, half of which have been lost since the 1870s.

Climate change is both a direct consequence of the loss of ecosystem integrity, as well as an increasingly important direct cause of ecosystem degradation. Areas of the world that will experience the most severe impacts from global climate change, biodiversity degradation, and the decline of ecosystem integrity are also home to many of the poorest human populations, who disproportionately rely on nature for their livelihoods and are most directly affected by its loss.

The loss of ecosystem integrity is thus much more than an ecological issue. Protecting and ensuring ecosystem integrity should be seen as the linchpin for developmental, social, and other goals.

- **Healthy communities and human development:** To date, research on the human health benefits of NbS has focused on urban settings, where NbS, such as city parks and green infrastructure, can help filter air pollutants, reduce flood risk, and provide clean drinking water, possibly reducing the rates of respiratory illness and infectious diseases (MacKinnon et al. 2019). However, the recent COVID-19 crisis brought into sharp focus the role that protecting nature can play in preventing the spread of zoonotic illnesses, whose rate of transmission is expected to increase with habitat destruction (Evans et al. 2020).

How can policymakers best understand the potentials and the pitfalls of NbS and decide how to prioritize various options and approaches? First, it is important to keep the concept of protecting, maintaining and restoring ecosystem integrity at the center of NbS (see Box 4).

Prioritizing ecosystem integrity as the unifying goal of NbS, in turn, yields decision criteria for choosing NbS approaches and efforts. Specifically, NbS should

- prioritize halting the loss and damage to natural ecosystems, particularly primary, carbon-dense and/or biodiversity-rich ecosystems, including primary forests, mangroves, and coral reefs;
- combine biodiversity and climate mitigation or adaptation outcomes to the extent possible;
- require the full engagement and consent of indigenous people and local communities affected by NbS measures;
- lead to a reduction in emissions—and not merely the shifting of responsibility for emissions; and
- not be used as a substitute for rapid phase-out of fossil fuels.

Applying the guiding principle of ecosystem integrity and these decision criteria, we argue that the highest priority ecosystems for developing and scaling NbS are the world’s remaining primary forests and the mangroves and coral reefs of the ocean’s tropical coastal zones.

Focus on Primary Forests

3.1 Why primary forests?

Although NbS need to be applied across a diversity of ecosystems, the single most important intervention to deliver synergistic climate and biodiversity outcomes on land is the protection of primary forests (see Box 5). The actions required to support climate mitigation and adaptation, biodiversity protection and recovery, and the provision of high quality ecosystem services align. As the IPCC has concluded (IPCC 2019), protecting carbon stocks in primary, carbon-dense ecosystems, which constitute around 36 percent (14.5 million km²) of the global forest estate (Mackey et al. 2015), offers superior and immediate climate mitigation benefits compared to planting new trees. Furthermore, carbon-dense ecosystems are irreplaceable in policy-relevant time frames (2030 and 2050).

In terms of biodiversity, primary forests are even more important than they are for climate change. Tropical primary forests alone may hold up to two-thirds of all terrestrial species, providing unique habitat characteristics critical for large numbers and a wide variety of plants and wildlife, including the hidden biodiversity—invertebrate and fungal diversity and soil biota—that underpin the productivity and stability of forest ecosystems. Many unique, specialized features are only found in primary forests and within forest interior micro-climates, and we are still discovering new species in them (IUCN 2020a).

In a time of unprecedented ecological change, primary forests also provide important reference areas for biodiversity and ecosystem integrity against which to assess the condition of degraded natural forests and the effectiveness of restoration action. Even small areas of primary forest are critical, serving as refugia for threatened species, core patches for landscape restoration, and connectivity conservation efforts initiatives and functioning as source habitats for ecological restoration (IUCN 2020a).

3.2 The significance of primary forest loss for climate change and biodiversity

The global area of naturally regenerating forest has declined throughout human history, halving over the past three centuries (Reid et al. 2005). Primary tropical forests continue to dwindle in most regions. According to the latest data on global forest loss compiled by Global Forest Watch (see Figure 5), the tropics lost nearly 12 million hectares of tree cover in 2019, with nearly one-third of that—3.8 million hectares, occurring within humid tropical primary forests—the equivalent of losing a football pitch of primary forest every 6 seconds for the entire year. Primary forest loss was 2.8 percent higher in 2019 than the year before and has remained stubbornly high for the last two decades, despite efforts to halt deforestation. Although the rate of primary forest loss was lower in 2019 than the record years of 2016 and 2017, it was still the third-highest since the turn of the century (Weisse and Goldman 2020).

This is bad news for climate mitigation efforts, because at least 1.8 gigatonnes of CO_2 emissions are associated with that 2019 primary forest loss—equivalent to the annual emissions of 400 million cars (Weisse and Goldman 2020). Tropical primary forests protect the largest living biomass carbon stocks, most of which is stored in big old trees. A recent study (Mackey et al. 2020) calculated that primary tropical forests store 49–53 percent of all tropical forest carbon with another ~25 percent stored in forest that has been subject to some land-use disturbance, and a further ~25 percent in more severely degraded forest.[5] As deforestation and degradation of tropical primary forests continues at significant rates (8; Curtis et al. 2016; Asner et al. 2010), this ongoing source of emissions is a significant threat to the prospects for stabilizing atmospheric CO_2 concentrations even if fossil fuel emissions are eliminated (Mackey et al. 2020).

In addition, above-ground living biomass is at best only 50 percent of total forest ecosystem carbon (Grace et al. 2014; Keith et al. 2009; Navarrete-Segueda 2018), resulting in emissions from deforestation and degradation likely being significantly underestimated and the mitigation benefits of primary forest protection undervalued (Mackey et al. 2020). This is particularly the case for tropical peat swamp forests (see Box 6).

Tropical forests have received the most attention in climate mitigation discussions, but primary forests in all biomes protect rich, relatively stable carbon stocks either above or below ground or both. For example, cool wet temperate forests are home to some of the most carbon dense forests on Earth, storing large amounts of carbon in big old trees, soil and the coarse woody debris on the forest floor (IUCN 2020a). Boreal forests also accumulate vast stocks of below-ground carbon, accounting for approximately 25 percent of

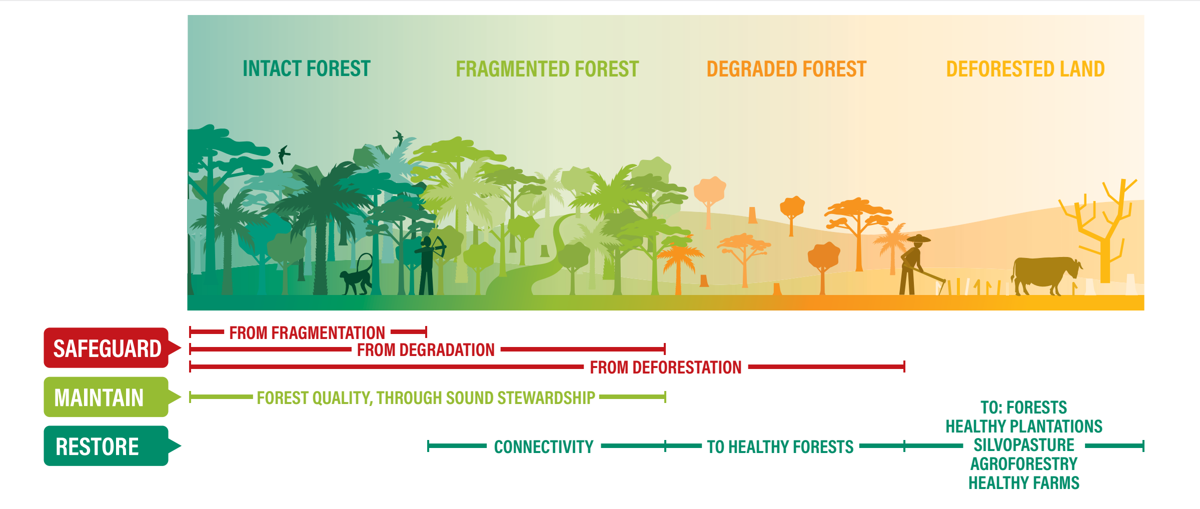
Box 5. What Are Primary Forests, and How Do They Differ from Other Forests?

The UN Food and Agriculture Organization (FAO) distinguishes between three major categories of forests: primary forests; production forests used for commercial logging or other industrial-scale activities (and that are affected by associated infrastructure), but still reliant on natural regeneration; and plantation forests predominantly composed of trees established through planting and/or deliberate seeding of commercial varieties and often using monocultures species that are exotic to the region (FAO 2018).

The term *primary forest* encompasses related terms and concepts, including stable forests (Funk *et al*. 2019); intact forest (Watson *et al*. 2018b); old growth; long-untouched and virgin forest (Buchwald 2005); ecologically mature forests; and intact forest landscapes (Potapov et al. 2017). Prior human intervention may have occurred in primary forests, but this was long enough ago to allow an ecologically mature forest ecosystem to reestablish (Ellis et al. 2019).

At the other end of the forest condition gradient (see figure 4) are severely degraded forests that require human intervention to enable regrowth. In between are naturally regenerating forests subject to conventional production forestry management. Based on the notion that homogenous products are cheaper to produce and manipulate, these conventional management practices have typically led to more even-aged and species-poor stands and now cover about 30 percent of the global forest land base (Puettmann et al. 2015). The most intensive form of silviculture results in plantation forest, typically monocultures, comprising trees established through active planting and/or deliberate seeding (Mackey et al. 2020).

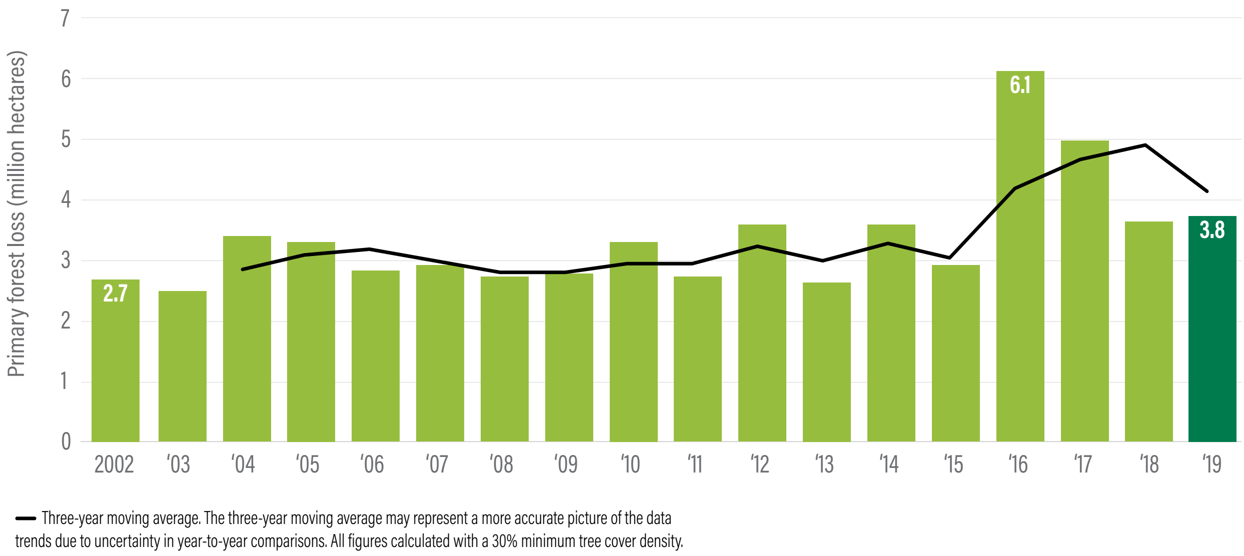
Figure B5.1. The Forest Condition Gradient



Source: World Resources Institute.

These three broad categories of forest condition also reflect differences in ecosystem integrity, stability, and resilience which are important for understanding risk associated with forest investment decisions, particularly investment in forest-based climate mitigation. For example, risks of reversal, loss, and damage resulting in premature release of GHGs to the atmosphere are minimized if investment is in improved conservation management, buffering, and reconnection of primary forests, while risks are significantly greater in planting monocultures of trees.

Figure 4. Tropical Primary Forest Loss, 2002–2019



Source: World Resources Institute.

the planet's forest area and containing more than 35 percent of all terrestrial carbon. Half of remaining primary (often called old-growth) forests are located in the boreal and temperate regions of the Northern Hemisphere. These forests are usually carbon sinks, steadily accumulating carbon for centuries with boreal and temperate forests alone sequestering at least 1.360. 5GtC/yr. (IUCN 2020a).

As noted earlier, tropical primary forests alone may hold up to two-thirds or more of terrestrial species, so their degradation and loss is catastrophic for biodiversity. Once forest biodiversity is lost, it is irreplaceable on any time scale meaningful to policy or people. Biodiversity generally declines along a coarse gradient from primary forest to secondary forest, agroforestry, plantations, arable crops, and pasture. Studies of regenerating forests demonstrate that biotic recovery occurs over considerably longer time scales than structural recovery, and that reestablishment of certain species and functional group composition can take centuries or millennia (IUCN 2020a).

3.3 The drivers of primary forest loss

In a world of accelerating economic activity and trade, population growth, and extremes of wealth and poverty, it is not surprising that forests have paid a heavy price. The drivers of deforestation are complex and vary from place to place, but they are not mysterious as a general matter. As Catherine Caufield (1984) wrote more than three decades ago:

Why destroy a forest? To sell its timber, to get at the gold and iron underneath, to get more land for agriculture. There are psychological motives too: the wish to conquer nature, the fear of the unknown, nationalistic and strategic desires to occupy uncontrolled regions.

Thirty-six years later, numerous case studies and meta-analyses have confirmed these succinct words. Many of the factors responsible for the rapid accumulation of deforestation-linked GHGs in the atmosphere are the same factors responsible for the rapid loss and decline in biodiversity and ecosystem integrity (IPCC 2019) and are the same ones that Caufield identified in 1984.

The main driver of forest loss in the tropics is the relentless expansion of globalized commercial agriculture, mainly in the form of large monoculture plantations as well as pasturelands for livestock. The impacts of different commodities vary across regions and over time (Seymour and Harris 2019), but overall, the global value chains of four commodities (soy, cattle, palm oil, and wood) are responsible for some 40 percent of deforestation (NYDF Assessment Partners 2019). Logging for timber does not typically result in immediate loss of forest cover in the tropics, but it is a major cause of forest degradation (including fire, poaching, and wildlife trafficking) and fragmentation due to the construction of roads (Laurance et. al. 2014).[6]

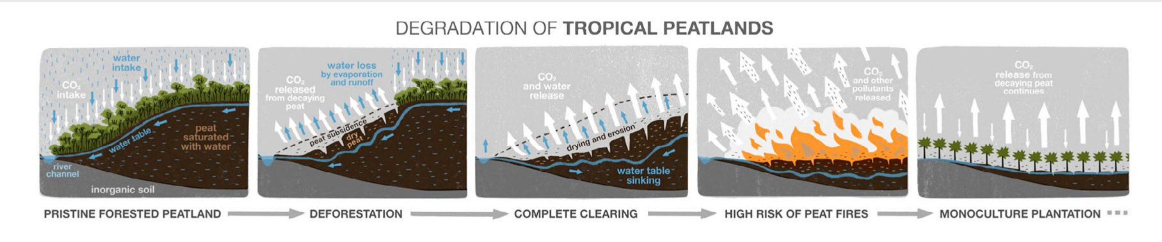
The long-standing policy of many countries not to recognize or protect Indigenous and other customary rights over lands officially designated as state-controlled forest has also contributed, fanning widespread conflict, and in many places has fueled an open access gold-rush mentality in which stewardship of the forest is the last thing on the minds of anyone (Stevens et al. 2014).

Box 6. Tropical Peat Swamp Forests: Ground Zero for Forest Carbon

Most abundant in parts of Southeast Asia and Central Africa, tropical peat swamp forests cover only a small part of the world's surface but are crucial for efforts to mitigate climate change. Peat swamp forests form in areas where saturated soils or frequent flooding prevent organic material from fully decomposing. Acting as a giant sponge that holds in moisture, peat swamps eventually form a dome of wet organic material that can rise above surrounding flood levels. Peat layers over 4 meters are common, while depths of up to 20 meters have been reported.

The accumulation of so much organic material means, these store a lot of carbon: up to 20 times more per hectare than nearby lowland forests on mineral soil. The amount of carbon stored in one hectare of tropical peat forest depends on the thickness of the peat, ranging from about 1,000 metric tons for depths of a meter to 7,500 metric tons in peat 13 meters deep. In addition to carbon currently stored, one hectare of healthy peatland sequesters an additional 0.5–1 metric tons of carbon per year. In 2017, scientists mapped the largest tract of peatlands in the tropics in the remote Cuvette Centrale Basin in the Congo. This one tract has accumulated more than 30 billion tons of carbon over 10,000 years.

Ninety percent of a peat swamp forest's carbon is stored below ground. If a swamp is drained, exposure to oxygen allows microbes to break down the organic matter, releasing its carbon into the atmosphere. Carbon that accumulated slowly over thousands of years can then be released in less than 100. Some estimates have calculated that as much as 3 percent of total global CO_2 emissions from human activity comes from draining and burning of peat swamp forests in Southeast Asia.



Tropical peat swamp forests are drained, logged, and cleared (often with fire) mainly for the expansion of oil palm, rubber, or other plantation crops. Areas where peat swamp forests have been degraded or destroyed are difficult to repair. To prevent the immediate loss of carbon through the breakdown of organics and encroachment by fire, the hydrology must be restored. However, trial projects have found that simply reflooding the peat by blocking drainage canals is largely ineffective. Restoration is not a practical option for these forests.

As the peat compacts due to oxidation or combustion, the soil level drops, and the peat loses its ability to reabsorb water and is therefore more susceptible to seasonal changes. During the wet season, areas become fully submerged, which prevents the germination and regrowth of forest species. Instead, water-loving ferns, sedges, and grasses replace the native vegetation. During the dry season, the water drains off quickly, and the ferns and sedges dry out and burn readily, causing further degradation of the land.

Fires in peatlands are difficult or impossible to extinguish. The fires can creep below the surface, smoldering deep into the organic buildup where they are inaccessible to crews and protected from rain. There, the fire can burn for years, flaring up during periods of drought when conditions are favorable. Strong El Niño, events in 1982–1983 and 1997–1998 caused severe droughts across Malaysia and Indonesia that allowed fires set for land-clearing to burn out of control, triggering a massive haze across the region and causing billions of dollars in economic damage. Extensive areas of peatland in Kalimantan and Sumatra have never recovered from those fires. Areas that were once inhabited by a wealth of wildlife and used by local people are today vast wastelands.

Sources: Nasi 2019; Bell 2014.

Box 7. Tropical Primary Forests as a Carbon Sink

While the principal mitigation value of primary forest ecosystems resides in their stored carbon stocks (Mackey et al. 2013), tropical primary forests are also a potentially significant sink for near-term additional carbon dioxide removal (Mackey et al. 2020). Contrary to the widely held view that carbon stocks in primary forests reach a fixed equilibrium amount (Xu et al. 2017), these stocks appear to be increasing monotonically throughout the tropics at a rate of 0.47–1.3 Pg C/yr^{-1} (Grace et al. 2014; Lewis et al. 2009; Mitchard 2018; Pan et al. 2011), equivalent to 5–13 percent of annual global anthropogenic emissions (IPCC 2018). The rate of sequestration in primary tropical forests is estimated to be approximately equivalent to the emissions resulting from deforestation, based on comparisons of atmospheric inverse models (Gaubert et al. 2019). This ongoing sink dynamic can be explained by several factors:

- Old-growth trees in tropical forests maintain high rates of carbon accumulation at later stages of their lifetime, with 70–80 percent accumulated in the second half of life when trees are 70 years or older (Köhl et al. 2017);
- Carbon storage in primary forests will continue to increase when canopies are dominated by tree species with greater tree longevity and hence biomass residency time (Castanho *et al*. 2016; Körner 2017); and
- The CO_2 fertilization effect – enhanced biomass growth due to elevated CO_2 levels (Donohue et al. 2013; Nemani et al. 2003; Pan et al. 2011).

Weak governance and corruption are significantly correlated with poor forest management, forest degradation, and uncontrolled deforestation (Hoare 2020). Under-investment in forest conservation and management is also often a factor, unsurprising given the under-valuation of forest ecosystem services inherent in conventional market mechanisms and in methods for measuring wealth and productivity such as GDP (Masiero et al. 2019).

Taken together, legal and illegal logging, conversion of forests for agriculture, the construction of new roads and dams, mining and fossil fuel extraction, and the associated expansion of human settlements have combined to push many forest ecosystems systems beyond their biological limits. Just at a time when governments should be most concerned about increasing encroachment on forests for public health reasons—as well as for long-standing concerns about climate change, biodiversity loss, and threats to the rights and livelihoods of indigenous peoples—forests are suffering increased threats resulting from the COVID-19 pandemic's economic and political fallout.

Focus on Coastal Ecosystems: Mangroves and Coral Reefs

4.1 Why coastal ecosystems?

The ocean covers three fourths of our planet. Its health and productivity are fundamental for life on earth and for efforts to combat and adapt to global climate change (see Box 8). Within that broad ocean context, this report focuses on the critical ecosystems lying within the ocean's coastal zone. Coasts and nearshore waters encompass only a small proportion of the world's oceans but are disproportionately important for achieving climate, biodiversity, and sustainable development objectives. From a climate-change mitigation perspective, coastal zones are home to carbon-rich mangrove, seagrass, and saltmarsh ecosystems, while tropical coral reefs hold the vast majority of the planet's marine and coastal biodiversity. Healthy coastal systems also constitute critical blue infrastructure, buffering coastal communities from storms, tsunamis, and sea-level rise. These coastal ecosystems also underpin the productivity of many fisheries, particularly those on which countless poor coastal communities depend for animal protein and livelihoods. Together with primary forests, these ecosystems form the core natural capital with which we can devise NbS to our climate and biodiversity crises.

Mangroves (as well as tidal salt marshes and seagrass beds)[7] are highly productive blue carbon coastal ecosystems, analogous to green carbon ecosystems on land (Nellemann et al. 2009). Mangroves are hotspots for carbon storage, with soil carbon sequestration rates per hectare up to 10 times larger than those of terrestrial ecosystems (Mcleod et al. 2011). Most of their carbon (50–90 percent) is stored within the soils where saltwater inundation slows decomposition of organic matter, leading to accumulation of extensive soil carbon stocks.

Mangroves are found mainly in the intertidal zones of coastal tropical and subtropical regions of the world (see Figure 6), overlapping with some of the most densely populated cities and coastal areas on Earth. There are about 80 species of mangroves across 123 countries, and they cover an estimated global area of between 13 and 15 million hectares, with 20 percent of the total found in Indonesia alone. Indonesia is home to 20 percent of all the mangrove area in the world. (Diazgranados and Howard 2019).

Seagrasses, while largely unseen, cover the shallow slopes of coastlines from the tropics to the Arctic. Like grasses on land, seagrasses form dense underwater meadows that provide habitat to a highly diverse community of animals, from tiny shrimp to large fish, crabs, turtles, and marine mammals, such as dugong and sea otters. Seagrass meadows are also important for fisheries, coastal protection, and maintaining water quality. From a blue carbon perspective, seagrasses are vitally important: While seagrass meadows occupy less than 0.2 percent of the ocean area, 10 percent of the climate change-causing carbon locked away permanently in the seafloor each year is removed by this ecosystem (Pidgeon 2019).

Tidal saltmarshes are unique and rich ecosystems dominated by thick grasses and shrubs that have adapted to live in muddy soils and salty water brought in each day by the tides. These saltmarshes improve coastal water quality and serve as habitat for a unique biodiversity including crabs, shrimp, fish, and thousands of migratory birds. Their vegetation continuously absorbs CO_2, and as each generation of plants dies, the carbon is preserved in the low oxygen and high-salt conditions of the soil below.

At many sites around the world, thousands of years of carbon-rich soil lie below tidal saltmarshes. At the same time, due to their coastal location, saltmarshes trap sediment as it washes across from both land and sea. Combining plant photosynthesis with the constant trapping and storing of carbon in the soil makes saltmarshes one of the most efficient ecosystems in sequestering carbon: up to 2.2 tons of carbon per hectare per year. And by combining large areas with their lush vegetation and muddy soils, saltmarshes reduce the impact of waves and storms, protecting against erosion and flooding (Ramos 2019).

Box 8. The Ocean and Climate Change

The ocean is the largest carbon sink on Earth, absorbing 30 percent of heat-trapping CO_2 that humans have released into the atmosphere. The oceans have also absorbed 90 percent of the extra heat, dramatically slowing the impacts of climate change on the atmosphere up to now. However, we know the future capacity of the oceans to continue as carbon and heat sinks will soon reach its limit.

As waves move and break at the interface of ocean and atmosphere, CO_2 passes from the air to ocean water. Currents then move that water and its CO_2 to all the corners of the ocean. Once reaching the deepest parts of the ocean, the CO_2 is locked away for millennia and can no longer contribute to climate change. The ocean is also filled with creatures that consume, cycle, and eventually sequester CO_2 into the deep ocean. The first to consume CO_2 are phytoplankton at the surface. Through photosynthesis, these microscopic plants use sunlight to combine water and CO_2 to produce energy, the foundation of the complex ocean food web. Phytoplankton feed everything from microscopic zooplankton to small shrimp and fish. Smaller animals are then eaten by bigger ones, and so carbon is cycled throughout the oceanic web of life.

All marine animals play an essential role cycling carbon through the oceans by building up carbon in their bodies and releasing that carbon when they breathe, defecate, and die, but phytoplankton are the standout, containing 0.5–2.4 billion tons of carbon globally. While most phytoplankton are consumed, a small yet important fraction (0.22 percent or 90.2 million tons of carbon a year) will die, sink, and become sequestered long-term in the sediments on the ocean floor. Through this process, phytoplankton sequester almost as much CO_2 as all the trees, grasses, and all other land-based plants combined.

Other plants and algae in the oceans and along coasts also absorb CO_2. Some, like mangroves, seagrasses, and tidal saltmarshes, bury carbon directly in the sediment below them and keep it sequestered for millennia. Large algae beds—like the extensive kelp forests along the coasts of California and Norway—absorb carbon while also providing critical habitat for unique and endangered biodiversity.

Although coastal ecosystems have received much of the attention regarding their role in storing carbon, a recent study shows that the top meter of sediment on the seafloor harbors 2.3 times more carbon than the top meter of all of the soils of the land (Atwood et al. 2020). Some of that carbon is disturbed by bottom trawling (and potentially by deep sea mining), potentially remineralizing to CO_2.

Every day we depend on the oceans to be a buffer against climate change, but the capacity of the oceans to remove carbon from the atmosphere and balance the Earth's climate is already weakening. The latest scientific predictions tell us that if we continue to increase CO_2 in our atmosphere, the oceans will no longer provide the protection from climate change on which we so critically depend.

Source: Howard and Pidgeon 2019.

Figure 5. Global Distribution of Mangroves

Source: UNEP-WCMC, in Romanach et al. 2018.

4.2 The Significance of coastal ecosystems for climate change and biodiversity

The area covered by blue carbon ecosystems is equivalent to only 1.5 percent of terrestrial forest cover, yet their loss and degradation are equivalent to 8.4 percent of CO_2 emissions from terrestrial deforestation because of their high carbon stocks per hectare. An estimated 20 and 50 percent of blue carbon ecosystems have already been converted or degraded, however, leading some analysts to conclude that restoring wetlands can offer 14 percent of the mitigation potential needed to hold global temperature to 2°C above the preindustrial period (Griscom et al. 2017). Mangroves alone, for example, constitute only 2 percent of the world's tropical forest area, but their annual degradation and destruction is resulting in 20 percent of global emissions related to tropical deforestation at some 2.25 billion metric tons of carbon dioxide each year: the equivalent annual emissions from over 475 million cars (Diazgranados and Howard 2019.) Mangrove ecosystems are also critical for biodiversity and for the well-being of millions of people dependent on mangroves for their livelihoods (see Box 9).

Rates of mangrove loss have declined from 2.1 percent per year in the 1980s (Valiela et al. 2001) to 0.11 percent per year in the past decade (Bunting et al. 2018), due to improved understanding, management, and restoration (Lee et al. 2019). Rates of loss and degradation of seagrass cover are, however, between 2 and 7 percent per year, mainly due to pollution of coastal waters (Duarte et al. 2008; Waycott et al. 2009), although gains in cover have recently been observed in Europe (de los Santos et al. 2019).

Tidal saltmarshes are also declining, having historically lost between 25 and 50 percent of their global extent due largely to conversion for agriculture, cattle ranching, and urban and industrial development. The amount of carbon in all tidal saltmarshes is estimated to be between 570 and 10,000 million tons. Given current rates of tidal saltmarsh loss (1–2 percent per year of the global extent), total global carbon emissions are likely to be up to 0.2 gigatons of CO_2 per year. Loss of all saltmarshes globally would result in up to 23 billion tons of CO_2 being released into the atmosphere (Ramos 2019).

Along with their role in capturing and sequestering carbon, blue carbon ecosystems constitute a key link in the productivity of many major fisheries and provide habitat for vast numbers of terrestrial and marine species. Mangrove forests also serve as critical natural infrastructure to buffer and moderate the impacts of disasters like hurricanes and tsunamis, as well as providing local coastal communities with nutrition, wood energy, and other necessities of life (Hoegh-Guldberg et al. 2019).

Coral reefs, while not a significant ecosystem for climate change mitigation, are centrally important for the world's biodiversity. Occupying less than 1 percent of the ocean floor, coral reefs are home to more than 25 percent of marine life. Coral reef species diversity is overwhelmingly concentrated in the coral triangle of Southeast Asia and the Western Pacific (see Figure 7). As is the case with primary forests, a highly biodiverse ecosystem is often more resilient to changing conditions and can better withstand significant disturbances.

Coral reefs also yield significant ecosystem services, providing millions of people with food, medicine, protection from storms, and revenue from fishing and tourism. An estimated six million fishermen in 99 reef countries and territories worldwide—over a quarter of the world's small-scale fishermen—harvest from coral reefs (Coral Reef Alliance 2020).

4.3 The Drivers of coastal ecosystem degradation

The world has lost nearly 3.6 million hectares of mangroves since 1980, with most of that loss occurring in Southeast Asia due to land-use changes, conversion of ecosystems for agriculture and aquaculture, illegal logging, and industrial and urban coastal development, among other human activities. These impacts are expected to continue and be exacerbated by climate change and population growth. Other major losses have also been reported in Central America and Africa, making mangroves one of the world´s most threatened ecosystems (Diazgranados and Howard 2019).

Indirect effects include factors such as changes in freshwater or tidal flow, pollution from oil exploration, and runoff from solid waste. Current projections of climate change and sea-level rise indicate that these could have multiple and varying effects on mangroves throughout the world. Because of their landscape position in the intertidal zone, mangroves are directly affected by sea-level rise, but the effects will depend on local topography, slope, the rate of sea-level rise, sources and amount of sediment, and extent of area for landward migration (Romanach et al. 2018).

Box 9. The Importance of Mangroves for Climate Change, Biodiversity, and Human Livelihoods

Mangrove forests are vital coastal ecosystems, providing unique habitat for a wide variety of plant and animal species. Numerous invertebrates, fish, amphibians, birds, reptiles, and mammals find shelter inside these forests. White-tailed deer, sea turtles, caimans, crocodiles, manatees, Bengal tigers, blue-billed curassow, and black clams are among some of the most endangered species found in mangroves.

Millions of people also depend on mangroves, which provide some of the world's most vulnerable communities with critical sources of food security, fishery resources, and income. Mangroves also act as a shield from natural disasters like hurricanes and tsunamis and reduce the impact of sea-level rise by building up the coastline as they grow and protecting land from erosion.

Mangroves also maintain coastal water quality by trapping sediment, nutrients, and pollutants, acting as a natural water purification system. This is particularly important in many tropical countries where urban populations have limited sewage and waste systems, and extensive shipping operations often pollute coastal areas. Lastly, mangrove forests have important recreational and cultural value to many coastal communities, bringing sustainable economic incomes from bird-watching and other nature-based tourism in addition to playing an important role in cultural practices and identity.

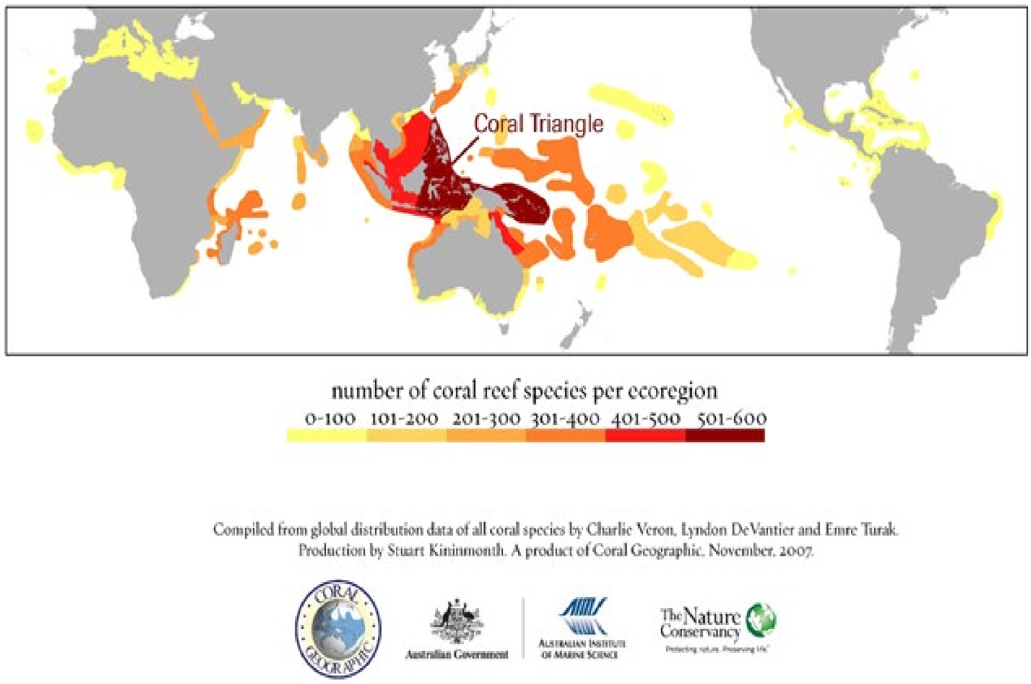
Mangroves are also critical for addressing climate change, removing up to four times more carbon from the atmosphere and ocean per hectare than terrestrial forests. As a consequence, mangrove ecosystems can store up to 10 times more carbon per unit area than terrestrial forests and are currently thought to store between 5.6 and 6.1 billion tons of carbon worldwide. In turn, when mangroves are degraded or destroyed, these carbon stores that took millennia to accumulate are released in a matter of years, turning an important carbon sink into a significant carbon source.

In Indonesia, 250,000 hectares of abandoned shrimp aquaculture ponds that were once pristine mangroves now emit up to 7 million metric tons of carbon dioxide per year. Restoring these abandoned ponds back to mangrove habitat would not only halt these GHG emissions, but also absorb up to 32 million metric tons of carbon dioxide annually. Taken together, the restoration of mangroves could result in 39 million metric tons of removed or avoided carbon emissions—the equivalent annual emissions of 8.1 million cars.

Halting ongoing mangrove loss and restoring mangrove forests globally provides a unique opportunity to simultaneously combat climate change, help millions of people adapt to its impacts, and conserve biodiversity.

Source: Diazgranados and Howard 2019.

Figure 6. Global Distribution of Coral Reef Species Diversity



Concerning threats to coral reefs, the last global assessment (Burke et al. 2011) reported disturbing negative trends:

- More than 60 percent of the world's reefs are under immediate and direct threat from one or more local sources, such as overfishing and destructive fishing, coastal development, watershed-based pollution, or marine-based pollution and damage.
- Of local pressures on coral reefs, overfishing, including destructive fishing, is the most pervasive immediate threat, affecting more than 55 percent of the world's reefs. Coastal development and watershed-based pollution each threaten about 25 percent of reefs. Marine-based pollution and damage from ships is widely dispersed, threatening about 10 percent of reefs.
- Approximately 75 percent of the world's coral reefs are rated as threatened when local threats are combined with thermal stress, which reflects the recent effects of rising ocean temperatures, linked to the widespread weakening and mortality of corals due to mass coral bleaching as well as ocean acidification.

Solutions: Protect, Restore, Connect

What will it take to turn around the decline of the planet's forest and coastal ecosystems so that they can fulfill their roles as the core of NbS to the climate and biodiversity crises? What must the UNFCCC and the CBD do, in their critical 2021 meetings and beyond, to summon the requisite political will and strengthen the international policy framework for action?

We argue for a three-pronged strategy of protect, restore, and connect:

- By *protect*, we mean protection of critical ecosystems through formal legal designation and effective management measures (such as recognition of Indigenous territories).
- By *restore*, we mean to encompass a broad range of measures and interventions to bring back the ecological integrity and/or economic productivity of degraded forest and coastal ecosystems.
- By *connect*, we refer to the need to ensure ecological connectivity across the land- and seascape through both protection and restoration, but also the need to maximize synergies and complementarities across efforts to mitigate and adapt to climate change, halt biodiversity loss, and promote sustainable and equitable development.

Cutting across all three strategies is the need for governments to put in place policies and measures to address the drivers of ecosystem degradation and conversion across the entire landscape.

5.1 Protect by expanding and effectively managing protected areas and other effective area conservation measures

Protected areas are the cornerstone of biodiversity conservation (Coetzee et al. 2014). Expanding and enforcing the current protected areas, both terrestrial and marine, is critical for protecting ecosystem function and achieving climate goals (Brondizio et al. 2019; IPCC 2019). Aichi Biodiversity Target 11 aims to achieve effective and equitable management of 10 percent of coastal and marine areas and 17 percent of terrestrial areas by 2020. There has been good progress toward this goal, with 15.2 percent of terrestrial land areas and 12.2 percent of national waters protected in 2020.

In addition, strengthening Other Effective Area-based Conservation Management (OECMs)—notably Indigenous territories—is a critical pathway to jointly support biodiversity, climate, and human development goals. More than 350 million people in 70 countries self-identify as indigenous peoples. They currently hold up to 22 percent of the world's land, containing 80 percent of global terrestrial biodiversity. Research has shown that indigenous territories have lower rates of deforestation than neighboring lands (Stevens et al. 2014) and the highest rates of biodiversity, even higher than protected areas (Shuster et al. 2019). The Kayapo People of the Brazilian Amazon provide one of the most compelling examples of why this is so (see Box 10).

As the Kayapo case demonstrates, designating areas as protected or placing them under conservation management should not be seen as counter to human development; protected areas are critical to achieving the SDGs by improving food and water security, increasing resilience of vulnerable populations, and promote human health and well-being (Naidoo et al. 2019). In addition, protected areas generate jobs associated directly with their management, as well as the tourism sector. For example, it is estimated that the Natura 2000 Network of protected areas in Europe supports 4.4 million jobs while contributing ecosystem services valued upward of $226 a year (Cook and Taylor 2020).

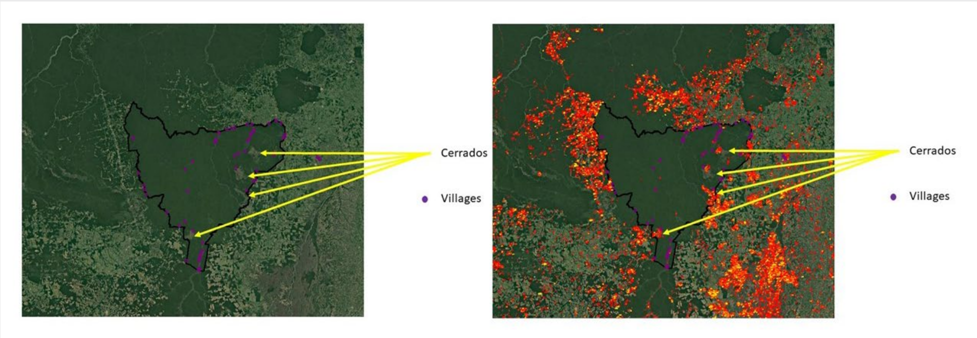
Recognizing and effectively protecting Indigenous rights over lands and resources is thus a key climate-change mitigation strategy. Recent research has indicated Indigenous that indigenous communities manage at least 22 percent of forest carbon and 17 percent of the total carbon, including soil carbon, stored in forestlands (Frechette et al. 2018). Yet, about one-third of the carbon in forests is located on community land that is not legally recognized, putting both the communities and stored carbon at risk. Securing these indigenous community rights is a cost-effective climate mitigation strategy that also ensures economic, social, and environmental returns to local communities (Ding et al. 2016).

OECMs are not restricted to the terrestrial realm. Locally managed marine areas in the hands of local coastal communities are expanding in many parts of the world and have been shown to be an effective marine conservation strategy, particularly in coral reef and mangrove areas of the developing world where local communities live in and obtain their livelihoods from these critical ecosystems (Rocliffe *et al*. 2014).

Box 10. Recognizing and Protecting Indigenous Rights as a Climate and Biodiversity Solution: The Kayapo Indigenous Territory in Brazil

The images below of the Kayapo Indigenous Territory during 2019's disastrous fires in Brazil illustrate both the importance of protecting primary forests and the key role that recognition and effective protection of the land and resource rights of Indigenous peoples can play in protecting those forests. Fires that spread through logging roads and clearings affected the edges of the territory and areas of natural savannah grassland (*cerrado*). However, the interior micro-climate of the primary forests, kept in good ecological condition by the Kayapo who have the rights and support to protect their territory from illegal logging and mining incursions, resisted and prevented the spread of the fires into their forestlands.

The impact of forest fragmentation and even light selective logging on the resilience and stability of these primary rainforests is clearly visible. Edge effects extend up to 2 kilometers into the forest from a road, making the forests vulnerable to drought and fire. Logging allows light and drying into the forest with similar effect.



Apart from the savannahs and villages, fires did not occur within the territory after July 1, 2019.

Kayapo territory forms the last large block (110,000 km²) of forest surviving in the southeastern Amazon and is a refugia for many endangered, threatened, and vulnerable mammal and bird species. Surveys show that most of Kayapo territory remains undisturbed as judged by population densities of the most sensitive game species, such as tapir, white-lipped peccary, and giant armadillo. The territory also plays a central role in conserving the exceptionally diverse fish communities native to the southeastern Amazon. The Kayapo protect 250 km of the Xingu River and 360 km of the Iriri River from deforestation, pollution, hydro-dam development, and overfishing. Forests provide the organic material that forms the basis of the aquatic food chain in addition to shelter, nesting, and nursery habitats. Forest conservation is therefore essential to aquatic as well as terrestrial biodiversity. The Kayapo also protect unique populations of high value timber tree species that are over-harvested in other areas. By conserving their forests, the Kayapo have protected more than 1.1 billion tons of carbon from premature release into the atmosphere.

The annual baseline budget for the three Kayapo NGOs to function and provide basic program support—including their territorial surveillance or guard post program, sustainable enterprise development (brazil nut, *cumaru* nut, ecotourism, handicrafts), and political mobilization (defense of Indigenous rights)—is only about $2.5 million per year with over $1 million of that raised by the Kayapo NGOs themselves.

Without legal rights to their land, the story of the Kayapo and their forests would be very different. International recognition and support has been important as well: Twenty-five years of philanthropic support helped the Kayapo maintain their culture and develop livelihoods based on non-extractive activities. The combination of rights-plus-support to protect their territory kept these primary forests intact, thereby preventing fire reaching into the forests; maintaining the ecological health and well-being of people, rivers, forests, and wildlife; and keeping vast amounts of carbon out of the atmosphere. Providing direct support to Indigenous communities to protect their territories and develop culturally appropriate development pathways based on improving the conservation management of their lands offers large and immediate benefit for global, regional, and local-scale environmental goals.

Source: Zimmerman et al. 2020.

Box 11. The Economics of Protecting 30 Percent of the Planet for Nature: The Waldron Report

The draft post-2020 Global Biodiversity Framework proposes an expansion of conservation areas to 30 percent of the Earth's surface by 2030, using protected areas (PAs) and other effective OECMs. Two immediate concerns are how much a 30 percent target might cost and whether it will cause economic losses to the agriculture, forestry, and fisheries sectors. Conservation areas also generate economic benefits (e.g., revenue from nature tourism and ecosystem services), making PAs or nature economic sectors in their own right. If some economic sectors benefit but others experience a loss, high-level policymakers need to know the net impact on the wider economy, as well as on individual sectors.

The current report, based on the work of over 100 economists or scientists, analyzes the global economic implications of a 30 percent PA target for agriculture, forestry, fisheries, and the PA or nature sector itself. (OECMs were only defined by the CBD in 2018, too recently to economically model, but we include a qualitative treatment of them.) We carried out two analyses: a global financial one (concrete revenues and costs only); and a tropics-focused economic one (including nonmonetary ecosystem service values), for multiple scenarios of how a 30 percent PA target might be implemented. Our financial analysis showed that expanding PAs to 30 percent would generate higher overall output (revenues) than non-expansion (an extra $64–454 billion per year by 2050).

In the economic analysis, only a partial assessment was possible, focusing on forests and mangroves. For those biomes alone, the 30 percent target had an avoided-loss value of $170–$534 billion per year by 2050, largely reflecting the benefit of avoiding the flooding, climate change, soil loss, and coastal storm surge damage that occur when natural vegetation is removed. The value for all biomes would be higher. Implementing the proposal would therefore make little initial difference to total (multisector) economic output, although a modest rise in gross output value is projected.

The main immediate difference between expansion and nonexpansion is therefore in broader economic or social values. Expansion outperforms nonexpansion in mitigating the very large economic risks of climate change and biodiversity loss. The 30 percent target would also increase by 63–98 percent the area recognized as Indigenous peoples' and local communities' land-based nature stewardship contribution (within appropriate rights and governance frameworks).

Economic growth in the PA or nature sector (at 4–6 percent) was also many times faster than the 1 percent growth expected in competing sectors. Marine expansion restores growth to fisheries (after a shock) but nonexpansion leads to a mid-term contraction.

The annual investment needed for an expanded (30 percent) PA system is $103–$178 billion. This figure includes $68 billion for the existing system, of which only $24.3 billion is currently spent. (Underfunded systems lose revenue, assets, carbon, and biodiversity).

Most of the investment needed is in low- and middle-income countries. These often have a competitive asset advantage in terms of natural areas, but they may need international support to capitalize on that opportunity. Otherwise, growing the PA sector could also entrench global economic inequalities.

Benefits and costs also accrue to different stakeholders at smaller (e.g., local) scales, making welfare distribution a challenge that needs addressing.

Source: Waldron et al. 2020 (adapted from Executive Summary).

Ensuring a more resilient and sustainable future will require increased recognition of the role that protected areas and OECMs play in meeting biodiversity, climate, and human development goals. But how much of the Earth can and should be protected?

One vision that is gaining currency, including in the CBD negotiations of the post-2020 Biodiversity Framework, is to expand conservation areas to 30 percent of the Earth's surface by 2030. A major recent study (Waldron et al. 2020) provides convincing evidence that this is not only feasible, but that economic benefits would outweigh costs (see Box 11).

Others have set their sights higher, at least on land, and made a convincing case for a global safety net protecting more than half of the Earth's land surface (Dinerstein et al. In Press). Making use of advancements in ecosystem monitoring technology, this study was able to analyze 11 spatial data layers to identify 53.4 percent of the terrestrial realm that, if conserved, would reverse biodiversity loss, increase carbon sequestration, and prevent future emissions from land-use change. These researchers provide evidence that connecting all the world's protected areas and intact areas would require only 3 percent of additional land surface and would bolster existing global restoration efforts. This technological and methodological advance makes it possible to greatly improve land-use planning efforts and to remotely identify ecosystems critical for biodiversity.

The Dinerstein et al. study (In Press) also provided the most comprehensive evidence to date of the significant overlap between areas that we need to conserve for biodiversity and for climate-change mitigation. While this overlap has been noted for some, the study provides detailed evidence of how and where to operationalize synergistic biodiversity or climate protection measures (see Figure 8).

The approaches of the Waldron (2020) and Dinerstein et al. (2020) studies are not mutually exclusive. It may only be politically feasible to set a 30 percent global target at the formal intergovernmental level for the time being. And 50 percent may not be practical or necessary for the entire ocean realm. For the terrestrial realm, a protection goal of 30% by 2030, 50% by 2050 could provide the iterative raising of ambition needed for both biodiversity and climate-change objectives and the sustainable development goals that they underpin.

5.2 Restore degraded forest and coastal ecosystems

As forest ecosystems have been degraded and deforested over the past few decades, attention to restoration has increased. Stabilization of severely degraded landscapes; reversing desertification; and improving the health of rivers, water catchments, estuaries, and nearshore coastal ecosystems, as well as improving the biological health of agricultural soils, all deliver long-term climate mitigation and adaptation benefits as well improvements for biodiversity, ecosystem integrity, and climate-resilient development.

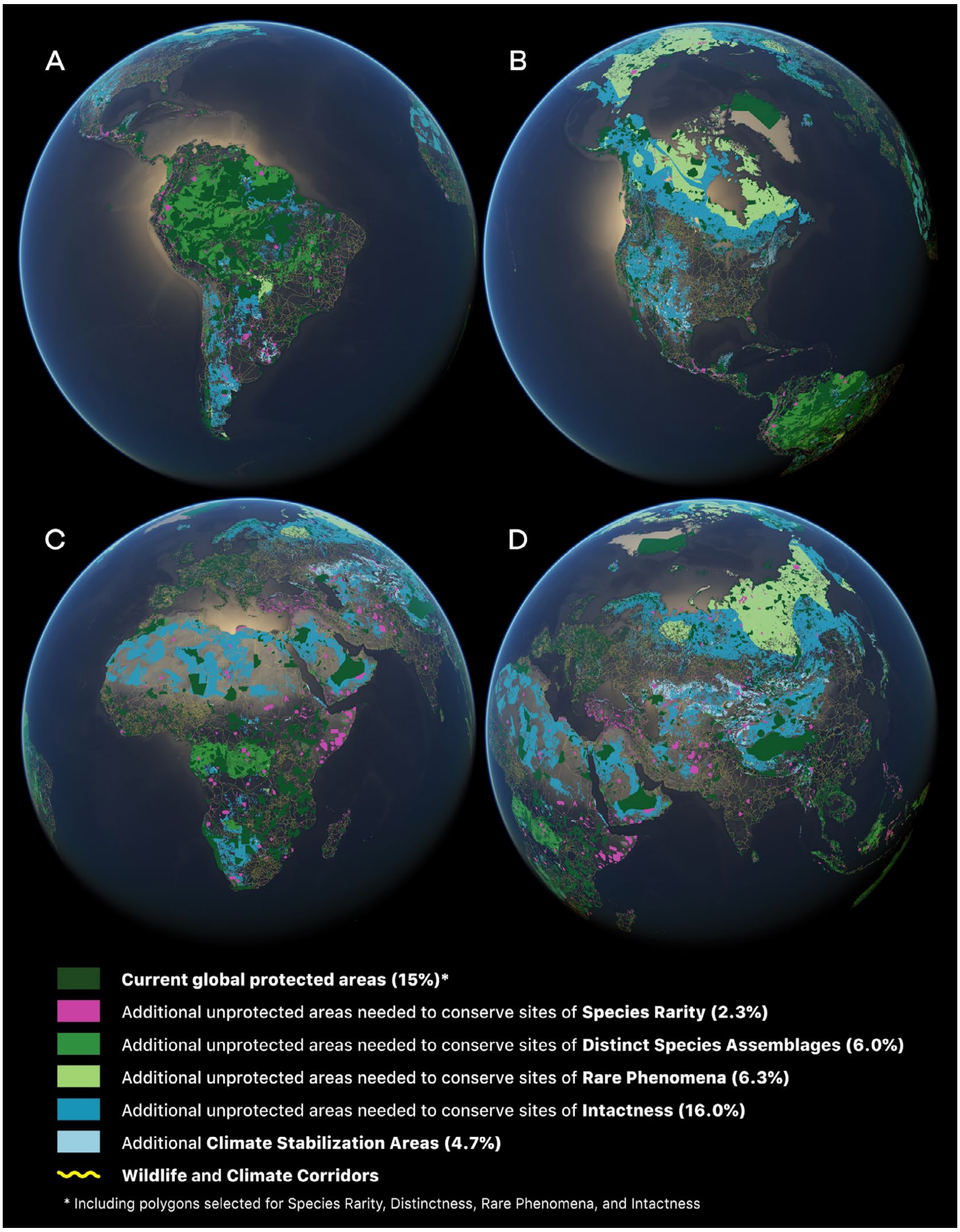
Considerable policy attention and investment from both governments and the private sector has turned in particular to the promise of forest landscape restoration. Notable recent efforts have included high-level political commitments such as the 2011 Bonn Challenge, the 2014 New York Declaration on Forests, and the 2020 Trillion Trees initiative. Regional initiatives include the 20x20 Initiative in Latin America and the AFR 100 initiative in Africa. The Global Mangrove Alliance has set a target of expanding mangrove habitat 20 percent by 2030 and catalyzing $10 billion in investments to that end. Numerous actors involved in restoration have come together under the framework of the Global Restoration Initiative and the Global Partnership on Forest Landscape Restoration.

The political will to restore degraded landscapes is high but translating forest landscape restoration commitments into action remains challenging. A five-year review of progress under the New York Declaration on Forests (NYDF Assessment Partners 2019) found that "only a fraction of the committed restoration goals has been realized as increases in forest or tree cover area. As of April 2019, there were 59 Bonn Challenge pledges from countries, jurisdictions, and companies totaling 170.6 million ha. of restoration commitments for 2020 and 2030 combined. However, evidence for restoration of forests amounts to only 18 percent of the 2020 forest landscape restoration goal (26.7 of 150 million ha. brought under restoration since 2000)."

In addition, there are lingering questions and divergent views about the extent to which restoration can actually contribute to climate mitigation (Zimmer 2019). As with NbS, the term *forest restoration* is being used loosely and sometimes misused to encompass a wide range of approaches from restoring the ecological integrity of degraded natural forests to replacing natural forests with industrial monocultures.

In a world with some 2 billion hectares of degraded forest lands, restoration must clearly be a priority, and it offers real prospects for making significant contributions to many of the SDGs, including poverty eradication and food security. However, the extent to which the landscape restoration efforts contribute to climate-change mitigation and biodiversity depends on the extent to which ecological processes and native biodiversity are deployed and the kinds of land uses that are subsequently put in place.

Figure 8. The Global Safety Net for Climate and Biodiversity



The Global Safety Net made more visible in a close-up of five biogeographic realms: (A) Neotropical, (B) Nearctic, (C) Afrotropical, and (D) Palearctic and Indo-Malayan (adjacent realms partly included).

Source: Dinerstein et al. In Press.

Box 12. The Proforestation Approach to Forest Restoration

Proforestation is a forest management strategy, based on enabling natural processes, that provides robust restoration NbS for both the climate and biodiversity crises by fostering continuous growth for maximal carbon storage and ecological and structural complexity, biodiversity, and habitat value (Moomaw et al. 2019). In forests whose carbon stocks have been depleted through logging and other land-use impacts, proforestation is an important mitigation approach as it can increase the amount of biological carbon sequestration during the critical coming decades by refilling the ecosystem carbon stocks that have been depleted by prior land use.

Importantly, as a mitigation strategy, proforestation does not require additional land and, where natural regeneration is still possible, requires few energy or industrial inputs and is very low cost compared to restoration strategies dependent on tree planting (Mackey et al. 2020). Proforestation can sequester more carbon per hectare than a planted forest growing over the same time period because the trees are established, larger, on the steepest part of their growth curve, and consist of the native mix of species.

Proforestation also delivers superior biodiversity and ecosystem service benefits compared to other forms of restoration, including even tree planting with biologically diverse native species. For the many species that are dependent on ecologically mature forests, it is an urgently needed biodiversity recovery strategy, since food and habitat resources required by species dependent on features only found in older forests clearly recover more quickly through proforestation than through planting new trees. Removing ongoing threats, such as roads, logging, and clearing, fosters faster recovery of biodiversity, ecosystem integrity, and stability.

With respect to climate-change mitigation in particular, many of the forest management practices inherent in current approaches to restoration do not accord with the latest scientific findings on forest carbon dynamics. Contrary to conventional forest management and restoration practices, the fastest way to recover previously depleted forest carbon stocks is not by planting new trees but, rather, by allowing existing and previously logged or otherwise degraded forests to keep regrowing through natural processes, a management principle known as "proforestation" (Moomaw et al. 2019; Mackey et al. 2020; Lewis et al. 2019; Keith et al. 2009). (See Box 12.)

Conventional forestry management maintains forests in the equivalent of a young, secondary regrowth phase. Reduced carbon stocks in these secondary forests mean they have the potential to sequester additional carbon at an accelerating rate for many decades or longer if allowed to grow to ecological maturity, that is, their primary forest state. This sequestration potential is the difference between the current carbon stock in a forest subject to conventional forest management for commodity production and its natural carbon-carrying capacity if allowed to recover fully without further logging (Keith et al. 2010).

The potential mitigation gains are nationally and globally significant. A recent study (Cook-Patton et al. 2020) that mapped global forest carbon accumulation found that the IPCC's default rates for estimating carbon removals by forest underestimate carbon sequestration rates in young forests by 32% globally, and by a full 50% for tropical forests. By using these default rates, many government are thus greatly underestimating the benefits of natural forest regrowth in capturing carbon dioxide from the atmosphere, and thus underappreciating its power as a nature-based solution to climate change (Harris et al. 2020).

The uptake of carbon by secondary tropical forest regrowth is estimated at 0.8 PgC - 1.6 PgC/yr^{-1} (Grace et al. 2014; Erb et al. 2018). In the United States and Australia, carbon stocks in previously logged natural forests are, on average, 50 percent below their biological potential or carbon-carrying capacity with the potential to sequester more carbon more quickly and store it more safely than through planting new trees (Mackey et al. 2020).

5.3 Connect across landscapes and across biodiversity, climate, and development strategies

Protection and restoration strategies must be knit together through connectivity, particularly in the terrestrial realm. Protected areas must function within a network connected by corridors as well as by integrating conservation measures into human-dominated parts of the landscape, including agricultural and silvicultural systems, settlements, and cities.

Landscape-scale connectivity initiatives were initially designed to foster biodiversity and ecosystem system recovery through facilitating wildlife movement and maintaining and improving trophic interactions,

Box 13. Nature-Based Solutions in Practice: The Ecological Redline Policy in China

Development of practical, integrated biodiversity and climate-change strategies at the national level requires a spatially explicit planning approach to optimize synergies and minimize conflicts between environmental and economic development objectives. China's recent experience provides one important example of how this can be achieved.

Following decades of rapid economic growth with significant negative environmental impacts, China has accelerated development of more ambitious and integrated policies to protect and restore natures since a catastrophic flood hit the central and southern regions of China along the Yangtze River and killed over 4,000 people in 1998. Over the past few decades, the concept of *ecological civilization* has become a guiding framework for balancing political, economic, social, and environmental policy objectives for the country; and in 2018, the concept was written into the Chinese constitution.

Within this framework, China has developed both national and provincial spatial zoning plans that cover and integrate critical ecological functions, agricultural production, and zones for industrial development and human settlements in recent years. Today, these spatial zoning plans are being consolidated by the Ministry for Natural Resources under a single and integrated land-use management plan for China. One key component of these planning frameworks is the concept of ecological conservation redlines (ECRL) that delineate areas for special protection or management, in order to minimize land cover change and prevent net biodiversity loss and degradation of ecosystem services. ECRL management categories range from strictly protected areas with no significant human presence to watershed protection areas that can sustain some agriculture and other human activities with limited ecological impacts.

Working at the scale of provinces and municipalities on up, the government identifies high-priority areas for biodiversity conservation, maintenance of ecosystem services, and disaster risk reduction in four steps:

- Develop an initial ECRL based on existing protected areas that are important for biodiversity (roughly 18 percent of the country) and additional priority areas identified through high-resolution mapping using remote sensing, survey data, and ecosystem services modeling.
- Align the ECRL with other land-use planning frameworks for agriculture, industry, mining, urban areas, and infrastructure.
- Scale and coordinate the ECRL across provinces and coastal areas to ensure continuity and effective management of cross-boundary ecosystems.
- Refine the ECRL boundaries in consultation with local governments to balance ecological needs and local development priorities.

The ECRLs are scheduled to be fully implemented in 31 of China's 34 provinces and municipalities by the end of 2020. Implementation challenges include land-use conflicts and complexities of land ownership, the resolution of which often necessitates complex negotiation processes. In order to facilitate agreed solutions, China is scaling up ecological compensation payments from the national government to local governments to compensate for local economic losses that may arise from the ECRL process.

Source: Schmidt-Traub *et al*. 2020.

particularly those associated with large herbivores and carnivores. The concept has since strengthened into a critically important biodiversity protection and restoration strategy capable of supporting the full range of ecological processes that influence natural systems (Crooks and Sanjayan 2006). In the face of already locked-in climate change, landscape connectivity is also now considered the preeminent strategy to maximize the adaptive capacity of biodiversity at all scales (Worboys et al. 2010). As an NbS, landscape connectivity also provides a strategy for synergistically increasing ecosystem carbon storage.

A key to maximizing the biodiversity and carbon benefits of restoration is to direct forest restoration actions spatially so that they buffer primary ecosystems and reconnect remnant patches. Reestablishing landscape-scale ecological connectivity between natural forests, woodlands and other important natural areas (e.g., rivers, wetlands, and coasts) is essential for biodiversity persistence and recovery. At a landscape scale, the spatial configuration of forest-based climate mitigation interventions can produce synergies and multiple benefits. Proforestation, reforestation, and restoration can be used to buffer the boundaries of primary forests from land-use pressures and other threats like fire, as well as to connect remnant primary forest patches and aggregate them into more stable and resilient blocks. Landscape conservation planning (Baldwin et al. 2018) with appropriately set objectives is a robust complementary strategy for improving climate-mitigation outcomes (Mackey *et al*. 2020).

Spatially explicit landscape planning is an effective tool for achieving forest restoration objectives that maximize biodiversity and climate-mitigation and adaptation outcomes as well as supporting the rights, aspirations, and livelihoods of indigenous and local communities (Baldwin et al. 2018; Mackey et al. 2020). In thinking about improving ecological connectivity and function at all scales, far greater attention is also now being paid to the health of whole landscapes. Stabilization of severely degraded landscapes, reversing desertification, improving the health of rivers, water catchments, estuaries, and nearshore coastal ecosystems, and improving the biological health of agricultural soils all deliver long-term climate mitigation and adaptation benefits as well improvements for biodiversity, ecosystem integrity, and climate-resilient development. China's ecological redline policy provides one interesting example of how this can be done (see Box 13).

Active restoration and regeneration of natural forests involving adjacent local communities is increasingly linked to improved agroecological farming practices. On-farm productivity is increased, allowing other areas of farmland to be restored to natural forests. Importantly, these large scale, ecologically based restoration and regenerative initiatives offer superior climate mitigation benefits, both in terms of the potential quantum of carbon sequestration and the stability and longevity of storage.

Moreover, the multiple benefits offered by these collaborative initiatives with communities across the landscape are attracting substantial investment, particularly where governance arrangements and implementation involve local landholders and communities (Gritten et al. 2018).

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Taking Action

6.1 Catalyzing NbS Uptake in the Climate Change Convention

Barriers to realizing NbS potential in the UNFCCC-Paris Agreement framework

The call to conserve reservoirs (stocks) of carbon in all ecosystems in UNFCCC Article 4.1(d) has never been applied to conserving natural ecosystems. This provision of the convention, which is reflected in Article 5 of the Paris Agreement, has never been operationalized and is a potentially significant stumbling block for fully implementing NbS in the UNFCCC context.

The IPCC Special Report on Global Warming of 1.5º (IPCC 2018) noted that, given the limited available time, substantially increased climate action in the land and forests sector would, if combined with deep cuts in industrial emissions, provide a pathway to limit warming to 1.5 degrees, the guardrail necessary to minimize climate impacts on biodiversity and ecosystem integrity. The 2019 IPCC Special Report on Climate Change and Land (IPCC 2019) reinforced this, stating that "while some response options have an immediate impact, others take decades to deliver measurable results. *Examples of response options with immediate impacts include the conservation of high-carbon ecosystems such as peatlands, wetlands, rangelands, mangroves, and forests.*" (Emphasis added.)

In forests alone, gross emissions are around 20 Gt CO_2 a year and gross removals 14 Gt CO_2, with the net flux being about 6 Gt CO_2 (IPCC 2019). Yet, if we could avoid all the emissions (e.g., by preventing deforestation and degradation) and maximize the withdrawals (e.g., through proforestation), then there could be 34 Gt CO_2 less in the atmosphere on an annual basis.

Yet, despite this guidance from the IPCC to conserve ecosystem reservoirs (stocks) as well as sinks, in practice the only ecosystems that currently have agreed (albeit deeply flawed) operational rules are forests and wetlands. Moreover, current rules focus solely on flows of GHG into and out of the atmosphere. Rules to reflect the climate mitigation value of improving the protection and stability of long-lived ecosystem carbon stocks are yet to be developed. The reasons for this situation are complex but are important to understand.

First, definitions and rules developed under the Kyoto Protocol for Land Use and Land-Use Change (LULUCF) result in all carbon in forests being treated as equal—an accounting framework that ignores the condition of the asset base—and as noted above, a sole focus on short-term flows of carbon into and out of the atmosphere. The effects of these definitional and accounting weaknesses have been profound: They have incentivized conversion of natural forests to monocultures of trees and played a significant role in the global failure to prevent degradation and loss of primary forests. Climate policy and practice have been blind to differences in ecosystem condition and stability, let alone the functional role of biodiversity as both a determinant and indicator of ecosystem condition. (Ajani et al. 2013; Mackey et al. 2013, 2020).

This situation may suit industrial-scale wood production interests, enabling the conversion (loss) of primary and other natural forests to be offset by planting new (including monocultures) of trees, but it yields perverse outcomes for both climate and biodiversity policy. Even five years after clear-fell logging, deforestation is deemed under LULUCF rules not to have taken place if a forest is to be replanted or regenerated. Also, forest degradation has never been defined even though the carbon stock in a wood production forest is on average 50 percent (30–70 percent) less than the average stock in a primary forest (Mackey et al. 2013).

Second, the functional role of biodiversity in ecosystem integrity and stability has never been considered, let alone reflected, in the operational rules. Relegating biodiversity to a potential co-benefit, treating all carbon in land and forests as equal—regardless of whether it is stored in a low resilience, high risk, monoculture tree crop; a medium integrity, medium risk natural wood production forest; or a high integrity, low risk primary forest—results in carbon being treated as fungible between agricultural tree crops and natural and primary forests.

Now that the world's attention is turning toward the potential of NbS to help solve the climate crisis, it is critical that approaches developed under the Paris Agreement properly reflect ecosystem dynamics and recognize the important role of biodiversity in contributing to stable, long-term carbon sequestration and storage. This requires changing the rules. To achieve effective climate mitigation, we must ensure that NbS also contribute to solving the biodiversity crisis. LULUCF rules must not be transposed to NbS, and natural forests must be treated in the same way as other natural ecosystems and not, as they currently are, as equivalent to agricultural tree crops. Only by doing so can we deliver synergistic climate and biodiversity action and avoid perverse outcomes for biodiversity and weak, high risk outcomes for climate mitigation.

How the UNFCCC accounts for carbon matters

Accounting for emissions from the land sector, including deforestation and degradation, is complicated by the fact that the land is simultaneously both a source of CO_2 emissions and a sink whereby atmospheric CO_2 is drawn down from the atmosphere through plant photosynthesis and stored in living and dead biomass and the soil. Accounting for these global carbon flows is typically done on an annual basis using a net accounting approach where emissions to the atmosphere from deforestation and degradation, including logging, are added to the withdrawals from the atmosphere by new tree plantings and re-growing natural forest, including previously logged forest. This net accounting approach masks the real potential of the mitigation benefits to be gained from simultaneously avoiding emissions by protecting primary forests and mangroves and fostering regeneration and restoration of degraded natural and agricultural ecosystems.

Estimates of global carbon accounts come from two sources—Earth system models and national GHG inventories reported under the UNFCCC—and both are considered to produce estimates that are in close agreement for land-use change involving forest (e.g., deforestation, afforestation) but differ for managed forest. The Earth System models are of increasing sophistication and accuracy. However, their ability is limited with respect to complex terrestrial biological and ecological interactions and feedback processes, including the functional role of biodiversity in ecosystem integrity. Key feedbacks include the resilience and adaptive capacity of ecosystems in response to changing climatic conditions. National GHG inventories are also limited here because the differences in the condition of ecosystems is not factored into reporting.

Experts have argued for years for development of stock accounts for land and forests because a dominantly geophysical focus on carbon fluxes has resulted in a focus on maintaining and increasing annual sequestration rates in forests at the expense of maintaining and improving the stability and longevity of forest carbon storage. This is a perverse mitigation outcome because the main mitigation value of forests resides in maintenance of the accumulated stock of carbon, not the transient flux rates (Mackey et al. 2013). The present net accounting approach used in national GHG inventories does not take into account the fact that when carbon is transferred from a long-lived stable and resilient stock (e.g., primary forests, healthy mangrove ecosystems) to one with a much lower level of ecosystem integrity, the risks of premature release of carbon into the atmosphere increase.

The UN System of Environmental and Economic Accounts is finally examining this issue with its consideration of the development of ecosystem stock accounts to help parties differentiate between differences in ecosystem condition and stability. In that context, ecosystem condition refers to the reference condition, which represents an ecosystem that attains maximum ecological stability: "The reference condition of an ecosystem corresponds to the condition where the structure, composition and function are intact and thus dominated by natural ecological and evolutionary processes, incorporating self-regeneration, and involving dynamic equilibria in response to natural disturbance regimes. An ecosystem in its reference condition attains maximum ecological stability" (Keith et al. 2009).

At the simplest level, differences between primary, natural production and monoculture ecosystems can be readily identified, as can the respective benefits and costs for the protection of biodiversity, the provision of key ecosystem services, and the quantum of carbon storage and risk of GHG emissions to the atmosphere. This continuum can inform priorities for management action and development pathways, whether based on improved conservation management and protection or restoration action (Palmer and Febria 2012).

These weaknesses in land and forest carbon accounting assumptions and methodologies frustrate attempts to integrate climate mitigation and biodiversity conservation efforts, and they may also be contributing to the difficulty that Parties are experiencing in acting on the opportunity provided by the Paris Agreement to integrate climate mitigation and adaptation action. This is important because improving the condition of natural ecosystems is just as important as an NbS for climate adaptation as it is for climate mitigation and preventing biodiversity loss.

Importantly, in December 2019, the UNFCCC gave the first indication that it may be ready to address weaknesses in current accounting rules that have effectively blocked operationalization of the ecosystem provisions of the UNFCCC and Paris Agreement (Article 4.1(d) and 5.1, respectively). COP 25 Decision 1/CP.25 noted "…the essential contribution of nature to addressing climate change and its impacts and the need to address biodiversity loss and climate change in an integrated manner." This language reflects increasing awareness by the Parties of the synergies between climate mitigation and adaptation objectives and the importance of maintaining and improving the condition, stability, and resilience of land, forests, and other natural ecosystems.

Integrating mitigation, adaptation, and biodiversity under the UNFCCC and Paris Agreement

The discussion of NbS under the UNFCCC tends to focus a good deal on mitigation. But NbS are equally important for climate change adaptation (see box 14). It is in linking the conservation and enhancement of key natural ecosystems that NbS can make the optimal contribution to coordinated climate and biodiversity solutions.

A promising approach to more fully incorporating climate-biodiversity synergies and NbS under the Paris Agreement lies in the Agreement's acceptance (in Article 5.2) of alternative policy approaches that link climate mitigation and adaptation activities by adopting landscape-scale approaches that encompass climate, social, and environmental benefits. This strategy allows for movement away from a carbon-centric view and provides the Parties with more flexibility to define what is needed to achieve robust mitigation and adaptation outcomes. Importantly, financing for such approaches may be accessed *ex ante* without prior need to demonstrate GHG emission reduction results as in the REDD+ pay-for-performance model, which has faced considerable practical and political hurdles.

As two veteran UNFCCC negotiators have argued, in implementing Article 5.2, developing countries would benefit from the integration of both mitigation and adaptation in land use through a landscape approach that aligns mitigation and adaptation objectives to achieving multiple social, environmental, and governance objectives. This requires an approach that emphasizes the conservation and enhancement of natural forests and biodiversity and does not result in the conversion of natural ecosystems to other land uses (La Vina and de Leon 2017).

The climate action plans of individual state parties, known as NDCs, allow individual state parties great flexibility as to which actions they will contribute to their mitigation targets and how they are to be reported and accounted for. Ensuring environmental integrity will be critical for success in effectively incorporating NbS into climate mitigation targets. Achieving synergistic climate and biodiversity action is feasible within NDCs. However, robust implementation under clear rules may require coordinated guidance from the UNFCCC and CBD on changes to carbon accounting rules and possibly a joint work program by the respective subsidiary bodies of the two conventions. It also requires countries to develop actionable maps for implementing NbS-focused NDCs, something few countries have done thus far (Schmidt-Traub et al. 2020).

It makes socioeconomic and ecological sense to tackle the biodiversity and climate crises together. Synergistic action to prevent and reverse biodiversity loss and mitigate and adapt to climate change is practicable, cost-effective, and achievable over the time frames relevant to both the Paris Agreement and the CBD post-2020 framework for biodiversity (2030 and 2050), provided that both the UNFCCC and CBD give greater emphasis to improving the protection and conservation management of natural ecosystems and revise the applicable UNFCCC rules to allow the Parties to do so themselves.

Box 14. Adaptation to Climate Change: The Role of Forest Ecosystems

Forest ecosystem services provide multiple benefits that can help people adapt to the current effects arising from the 1°C of global warming we are experiencing as well as the climate-related risks and effects from climate change already in the pipeline (CBD 2009). Maintaining and restoring ecosystem integrity therefore is an important NbS for human adaptation that can readily be incorporated into most NDCs.

In natural ecosystems, adaptation is, in large part, a function of natural selection operating on the genetic diversity found within populations of species, resulting in the characteristic biodiversity best suited to environmental conditions. This, in turn, generates system-level outcomes like ecosystem stability and resilience.

At a time of rapid climate and other change, maximizing available genetic, species, habitat, and ecosystem diversity is a key strategy to support natural adaptation responses. Critically important for successful ecosystem-based adaptation is understanding that, to keep pace with climate change, many tree and animal species will need to migrate at paces that may far exceed those observed in the historical-paleo record. Human barriers and fragmentation make the situation far worse. This is a key reason why NbS should be implemented systematically using the landscape approach.

Box 15. Recommendations for Action at UNFCCC COP26

UNFCCC COP26, currently scheduled for November 2021, and is seen as a pivotal inflection point for progress on climate change. As the UN Secretary General stated in March 2020, "If we are going to limit global heating to 1.5 degrees Celsius, we need to demonstrate, starting this year, how we will achieve emissions reductions of 45% from 2010 levels this decade, and how we will reach net-zero emissions by mid-century (Guterres 2020)."

As this report and many others have argued, there is a very strong case that this necessary level of ambition cannot be reached without robust use of NbS as part of both mitigation and adaptation, and this view has been gaining political currency. As COP26 President Alok Sharma noted in his closing remarks to the high-level Petersburg Climate Dialogue in April 2020, "So many colleagues made comments on the importance of nature based solutions, ensuring that solutions that we have in terms of fixing climate change must integrate nature based solutions….Whatever we do, we [must] have nature based adaptation and biodiversity protection at the heart of our work in tackling climate change (Sharma 2020)."

This can only happen if the Parties at COP26 adopt robust principles to elevate the priority of NbS, and concrete policy and procedural steps to enable that priority to be turned into meaningful action.

Principles

- Reinforce and build on COP25 Decision 1/CP.25, which noted "…the essential contribution of nature to addressing climate change and its impacts and the need to address biodiversity loss and climate change in an integrated manner." COP26 need to reaffirm, strengthen and operationalize this important principle.
- Recognize the functional role of biodiversity in maintaining ecosystem integrity and stability as a key principle for UNFCCC operational rules on land use and forests.
- Explicitly recognize the importance and give priority to conserving, restoring and connecting the most carbon-dense ecosystems, including primary forest, peatlands, mangroves, seagrasses and tidal saltmarshes as key foundations for climate change adaptation and mitigation.
- Welcome and further develop "alternative policy approaches" (UNFCCC Article 5.2) that link climate mitigation and adaptation via landscape-scale approaches that encompass climate, biodiversity and socio-economic benefits.

Rules and Processes

- Recognize carbon "stock accounts" for land and forest ecosystems – in addition to the current focus on carbon flows and fluxes – building on the work as well as sinks, building on and encouraging work on this topic under UN System of Environmental and Economic Accounts (UN SEEA).
- Establish a post-COP26 intersessional mechanism to take forward technical and policy work on NbS either under the SBSTA or through constitution of an *ad hoc* working group.
- Propose, in consultation with the CBD, a process and institutional mechanism to enhance and facilitate cooperation between the two processes on joint/coordinated action on developing and scaling NbS that at once address the climate and biodiversity crises.

An NbS Agenda for UNFCCC COP 26

The United Kingdom, as president of UNFCCC COP 26 (currently slated for November 2021) has indicated that it wishes to highlight NbS as a key part of a successful COP 26 outcome and has also worked with China (president of CBD COP 15, also slated for 2021) to enhance potential synergies between the two processes. So, what can Parties accomplish on NbS at COP 26?

While Parties already have the option of including actions in their NDC's that integrate climate mitigation and adaptation, prevent biodiversity loss and protect and restore ecosystem integrity, current UNFCCC operational rules are inappropriate for this purpose. If NbS are to become more than a popular slogan in the climate change context, the accounting rules and approaches to operationalize the ecosystem provisions of the UNFCCC and Paris Agreement need to be changed. There are two potential pathways for COP 26 to move in this direction:

The first pathway focuses solely on the UNFCCC. In light of UNFCCC COP decision 1/CP.25, the Parties could establish a SBSTA work program under Article 5.1 of the Paris Agreement, or could establish a separate SBSTA work program under Article 6.8,[9] either of which could operationalize the ecosystem provisions of 5.1 (and UNFCCC 4.1(d)) and give effect to Decision1/CP.25.

The second pathway is to encourage synergistic action between relevant environmental conventions. This would require a joint CBD-UNFCCC work program to identify and encourage synergistic action and to mobilize a jointly-agreed pool of funding aimed at delivering relevant ecosystem protection and restoration objectives for the two conventions. Such an approach could also take into account and coordinate with other relevant international instruments, including the UN Convention to Combat Desertification and the World Heritage Convention.

Either of these pathways would need to be championed at a COP presidential level as either a UNFCCC or joint CBD-UNFCCC presidential initiative. Regardless of which pathway eventually attracts the most support, it will be crucial to mobilize a coalition of Parties who believe that NbS are a key strategy to champion such an effort within the convention processes.

6.2 The CBD and the Post-2020 Global Biodiversity Framework

Debates in the UNFCCC focus on the extent to which NbS can and should be employed as a climate mitigation solution, and about what accounting and other procedural rules should apply. The situation in the CBD is rather different. The very premise of the CBD is that conserving and sustainably using biodiversity is in fact a "nature-based solution" for many of the problems facing both people and the planet. So too, there is little debate that climate change is having increasingly negative impacts on many aspects of biodiversity and ecosystem resilience and health.

Problems arise, however, in channeling those two areas of broad consensus into practical proposals and actions to mobilize NbS with the urgency and at the scale necessary to ensure that NbS become a practical and effective climate solution. The root of these problems lie in the nature of the topic of "biodiversity", the history and institutional development of the Convention over the past three decades, and the political battle lines that have emerged – and often hardened – during that period, both within the CBD context and in the relationship between the CBD and the UNFCCC.

"Biodiversity" is in many ways a more diverse and complex topic than climate change. Methods to measure biodiversity and its loss do not exist – we can only determine biodiversity condition and trends by measuring various proxies (e.g., diversity of various groups of species, endemism) and the use of different proxies yield different results in terms of threat analysis and priorities for action. So too, there is no agreed "apex goal" for international efforts on biodiversity loss that is comparable to the 1.5 degree goal in the climate change context. "Biodiversity" thus means different things to different people, communities and countries, and as a result the CBD is a complex agreement that has only grown more complex in the three decades since it was negotiated.

Intergovernmental discussions that would lead to the negotiation of the CBD commenced in late 1988 and concluded in mid-May 1992, less than a month before the treaty was opened for signature at the June 1992 Earth Summit in Rio de Janeiro along with the UNFCCC. In the course of negotiations, the scope of the CBD expanded beyond conserving natural ecosystems and preventing extinction to encompass both "sustainable use" of biodiversity's components and the "fair and equitable sharing of the benefits arising out of the utilization of genetic resources." One provision also mandated efforts to "respect, preserve and maintain knowledge, innovations and practices of Indigenous and local communities embodying traditional lifestyles", drawing the Convention into fiery debates about Indigenous land rights and intellectual property law.

Subsequent protocols to the CBD created *de facto* sub-conventions encompassing regulation of genetic engineering (the 2000 Cartagena Protocol) and on genetic resources access and benefit-sharing (the 2010 Nagoya Protocol).

Against this backdrop CBD Parties have agreed to a number of time-bound biodiversity targets related to slowing biodiversity loss:

- In 2002, the Parties to the Convention committed themselves "to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on Earth."
- In 2010, having acknowledged the failure to meet the 2010 Target, the Parties agreed on a broader set of targets for 2020, the 20 "Aichi Biodiversity Targets".[10] It is safe to say that the target related to extinction - which states that by 2020 the extinction of known threatened species will have been prevented and their conservation status, particularly of those most in decline, will have been improved and sustained – will not be met.

In 2018, CBD Parties established a process to develop a Post-2020 Global Biodiversity Framework (GBF), which the Parties mandated that it "should be accompanied by an inspirational and motivating 2030 mission as a stepping-stone towards the 2050 vision". The decision also mandated the framework to include "ambitious, measurable, realistic and time-bound targets" and associated indicators. Parties originally set a deadline for finalizing the GBF at the 15th CBD Conference of the Parties (COP-15), originally scheduled to take place in October 2020 in Kunming, China, but now postponed until the fourth quarter of 2021.

The work of the Open-Ended Working Group (OEWG) established to negotiate the GBF has also been delayed by the pandemic, after the group met once in mid-2019 and again in early 2020. The Co-Chairs of the OEWG provided Parties with a Zero Draft in early 2020, which was discussed at the second OEWG meeting and is currently the subject of informal consultations. The OEWG is not expected to meet until sometime in 2021 at the earliest and a revised version of the Zero Draft had not been released as of October 2020.

Despite the substantive linkages and synergies between the challenges of reducing biodiversity loss and combating climate change, as discussed above and as identified by the CBD itself (CBD 2009), the two conventions operate largely in their own silos, for primarily political reasons:

- First, climate change negotiators in particular are suspicious of "forum shopping" – a country or group of countries that are dissatisfied with one or another decision outcome in the UNFCCC may go and press their point in the CBD in an attempt to get a more favorable outcome that they can then use in turn to influence the UNFCCC process. They therefore advocate maintaining strict boundaries around the respective mandates of the two agreements.
- Second, there is competition between the two camps for international funding from multilateral and bilateral sources, and what may be couched as an appeal for "synergy" from one side may appear to pose the threat of a raid on "their" funding for the other side.
- Third, technical solutions for the forest and land use dimensions of climate change on the one hand and biodiversity on the other have often been caricatured rather simplistically as either/or alternatives. From a biodiversity perspective, for example, it makes sense to give highest priority to conserving intact expanses of primary tropical rainforest. But from a REDD+ climate negotiator's perspective, however, there is no "additionality", carbon-wise, in conserving remote, primary forests because UNFCCC/Paris Agreement approaches and rules have focused on forest carbon fluxes to the exclusion of the stocks contained in stable primary forests and other ecosystems with high levels of ecosystem integrity.

The longstanding pressures that have frustrated attempts at a more holistic climate-biodiversity approach in the CBD began to ease a little bit at CBD COP14 in the end of 2020:

- COP Decision 14/5 expresses the Parties' deep concern "that escalating destruction, degradation and fragmentation of ecosystems would reduce the capacity of ecosystems to store carbon and lead to increases in greenhouse gas emissions, reduce the resilience and stability of ecosystems, and make the climate change crisis ever more challenging," and recognizes that "climate change is a major and growing driver of biodiversity loss, and that biodiversity and ecosystem functions and services, significantly contribute to climate change adaptation, mitigation and disaster risk reduction."
- COP14 Decision 14/30 addresses cooperation among conventions and encourages "consideration of actions for enhanced synergies among biodiversity-related conventions, the Rio Conventions, and other conventions…in the development of the post-2020 global biodiversity framework…"

These two decisions provide the basis for establishing a more synergistic relationship between efforts to conserve biodiversity and to mitigate and adapt to climate change in the Post-2020 GBF, and for raising the political and practical profile of NbS as a key response strategy.

Box 16. Recommendations for Action at CBD COP15

A successful outcome at COP15 will require both adoption of a strong Post-2020 Global Biodiversity Framework and agreement on supporting decisions to enable and empower implementation of the actions called for in that framework.

The Global Biodiversity Framework should include the following elements:

- Explicit recognition of the centrality of *conserving and restoring ecosystem integrity* to biodiversity conservation, climate-change mitigation and adaptation, and the prevention of future zoonotic emerging infectious diseases;
- *A no-loss target for the most carbon-dense, high-biodiversity ecosystems*, including specific attention to primary forests, peat forests, mangroves, coral reefs and other coastal ecosystems;
- A target of including at least 30 percent coverage of the Earth's surface in *protected areas and other effective conservation measures* by 2030, with associated targets, including specific attention to the most carbon-dense, high-biodiversity ecosystems as specified earlier;
- A target that explicitly recognizes the *rights of Indigenous Peoples and local communities* (IPLCs) and the importance of recognizing and supporting IPLC territories and conserved areas as an integral part of the global biodiversity conservation framework and strategy;
- An *ecosystem restoration* goal focused on rebuilding ecosystem integrity and stability by prioritizing landscape-scale connectivity strategies and initiatives that repair and reconnect natural habitats, improve agroecological practices, and explicitly factor in reduction of threat factors for zoonotic emerging infections diseases; and
- A target on mobilizing new and expanded *finance and other means of implementation* to incentivize and mobilize NbS and other measures to achieve all of the goals and targets just mentioned.

Supporting COP15 Decisions need to

- recognize the importance of NbS for both climate-change mitigation and adaption, affirm the role of the CBD in addressing climate change challenges, and take a leading role in promoting NbS to address those challenges;
- establish an intersessional *ad hoc* working group or other process to address development and application of NbS for climate-change mitigation and adaptation, as well as for reducing risks of future zoonotic emerging infectious diseases like COVID-19; and
- propose, in consultation with the UNFCCC, a process and institutional mechanism to enhance and facilitate cooperation between the two processes on joint or coordinated action on developing and scaling NbS that at once address the climate and biodiversity crises.

NbS are not without controversy in the CBD process, it should be noted, with respect to their potential role in climate change mitigation. At the 2nd OEWG meeting (February 2020), it was clear that some Parties view NbS as a potential vehicle to shift the blame for climate change – and the burden of response – away from developed countries towards developing countries. On the other hand, China, the President of COP15, has expressed support for NbS approaches to climate change and co-chair the "NbS Track" during the 2019 UN Climate Action Summit. Many have expressed optimism that as COP15 President, China will use its leadership position to help Parties navigate this issue.

COP15 in Kunming presents a historic opportunity to revitalize action on the CBD's daunting but essential mission – to slow the accelerating loss of the variety and variability of life and its increasingly devastating impacts on humanity. This mission already vital in 1992. Today, however, we have come to realize that the climate and biodiversity crises are so intertwined that they have become for all practical intents and purposes, one planetary environmental crisis that demands an integrated solution. So too, the COVID-19 crisis has starkly demonstrated that the human health and the health of our planet's ecosystems and biodiversity are also tightly linked.

Can COP15 rise to this challenge? We believe that it can and it must, and to that end, based on our analysis in this report, we offer nine recommendations for action at the Kunming summit.

6.3 Building Back Better Using NbS – Priorities for the G20

The G20 is not a formal organization or an international treaty but it can play a potentially critical role in catalyzing international cooperation and action on the intertwined climate and biodiversity crises. Comprised of nineteen countries plus the European Union, the G20 members represent 80 percent of global GDP, 75 percent of global trade, and two-thirds of the world's population (McBride and Chatzky 2019). The Group also accounts for 80 percent of trade in agricultural goods, 60 percent of the world's agricultural land, 80 percent of GHG emissions, and the majority of the world's forests (Warren 2020). Formed in 1999 in the aftermath of the Asian Financial Crisis, annual G20 summits at the level of heads of state and government commenced in 2008.

Primarily a forum for informal exchange and coordination on economic issues, the G20 has also periodically highlighted climate change and related environmental issues over the past decade. As climate change and biodiversity loss have increasingly been viewed as economic as well as environmental challenges, this focus has intensified, albeit with notable ups and downs.

At the G20 Summit in September 2009 (Pittsburgh, USA), Indonesian President Susilo Bambang Yudhoyono staked out a leadership position among developing countries, noting that "many [developing countries] ask how can we spend the limited resources that we have on climate change, which in their eyes is caused by pollution generated in industrial countries from decades ago and should therefore be their responsibility?" He went on to note developing countries' resources constraints and appealed for international assistance, but nevertheless announced that Indonesia would pursue a climate mitigation policy, heavily reliant on reducing deforestation, that would aim to reduce emissions by 26 percent from business as usual by 2020 via Indonesia's own efforts, and as much as 41 percent with international assistance. He emphasized that "this target is entirely achievable because most of our emissions come from forest-related issues, such as forest fires and deforestation (Yudhoyono 2009)."

This bold statement paved the way for other developing countries to make similar commitments, and for developed countries to establish cooperation with developed countries to reduce GHG emissions from deforestation and forest degradation. In Indonesia, a decade later and under a new president, that 2009 G20 commitment yielded tangible results, with Indonesia dramatically reducing primary forest loss for the years 2017 through 2019 (Weisse and Dow-Goldman 2020).

In 2016, U.S. President Barack Obama and Chinese President Xi Jinping chose the G20 summit in Hangzhou, China to announce that they had both formally ratified the Paris Agreement. With the two countries accounting for nearly 40 percent of global GHGs, this highly visible demonstration of cooperation provided an incentive for others to follow suit. As President Obama noted at the time, "Despite our differences on other issues, we hope our willingness to work tougher on this issue will inspire further ambition and further action around the world" (Landler and Perlez 2016).

There have been setbacks. Obama's successor, Donald Trump, announced his intention to withdraw the United States from the Paris Agreement in June 2017, a withdrawal that takes effect under the Agreement's rules, on November 4th, 2020 (the day after the U.S. presidential election). Given the political divide on climate change between the Trump Administration and other G20 members, the issue has not received as much direct attention since that time.

G20 attention to biodiversity issues, on the other hand, has increased. The 2017 G20 Hamburg Summit Leaders' Declaration devoted five paragraphs to biodiversity, including calls for action on illegal trade in wildlife, sustainable agricultural production and food systems, and ocean conservation. And the 2019 Osaka Summit marked the first time the G20 leaders endorsed "nature-based solutions" as well as "ecosystem and community based approaches, nature based solutions and traditional and indigenous knowledge" as key solutions for addressing climate change (Warren 2020).

In light of the pivotal UNFCCC COP26 and CBD COP15 meetings taking place in 2021, the G20 Summit in November 2020, hosted by Saudi Arabia, and the incoming 2021 G20 presidency of Italy are in a strategic position to provide the critical mass and momentum needed for ambitious decisions and concrete action on climate and biodiversity during 2021 and over the coming decade.

Saudi Arabia has already laid out "Safeguarding the Planet" as one of its three priority aims for its presidency, including a focus on managing emissions for sustainable development; combating land degradation and habitat loss; and preserving the oceans; Their agenda explicitly refers to the importance of "nature-based solutions such as reforestation and protecting and restoring marine resources" (KSA 2019). That agenda was written, however, before the emergence of COVID-19.

It is clear that the 2020 Summit – and much of the G20's 2021 agenda – will largely focus on COVID-19 response and recovery, building on the Extraordinary G20 Leaders' Summit Statement on COVID-19 issued on March 26, 2020 (G20 2020). But the summit is unlikely to completely forego a focus on the climate, biodiversity, oceans and other environmental issues that Saudi Arabia has laid on the table. Indeed, the pandemic has in some ways intensified attention to imbalances between people and nature, and efforts to redress that balance, as previously discussed.

Thus far, the G20 response to the pandemic has focused on restarting economic activity and trade and facilitating immediate public health challenges. Given the increasingly well-documented linkages between disturbance of natural habitats – particularly tropical forests – and risks of future zoonotic pandemics, however, the 2020 Summit provides an opportunity to ensure that the G20 response to the COVID-19 crisis is synergistic with key priorities for combating biodiversity loss and climate change.

There are three key areas where the G20 can catalyze global political will and concrete action on the intertwined crises of COVID-19 recovery, climate change and biodiversity:

- First, the G20 can explicitly reaffirm the principle, found in both UNFCCC and CBD decisions, that the conservation of the most carbon dense and biodiversity-rich natural ecosystems is a key priority for a raising climate change ambition in the UNFCCC framework, establishing a strong Post-2020 Biodiversity Framework under the CBD, and reducing risks of future zoonotic pandemics.
- Second, the members of the G20 at the Summit level stand above the negotiating "silos" of the UNFCCC and CBD, and are in a position to send a strong political message on the need for cooperation across the conventions around the adoption and scaling of NbS as a multi-purpose solution for climate mitigation and adaptation as well as the conservation and sustainable use of biological diversity (see Boxes 15 and 16).
- Third, the G20 can commit itself to a green and just economic recovery from the COVID-19 pandemic, building win-win NbS into stimulus and recovery packages (See Box 17).

Box 17. 10 Recommendations to the G20 for Green COVID-19 Recovery Measures

- **Avoid relaxation of environmental regulations in the name of COVID-19 stimulus and recovery.** Some governments are relaxing environmental protection and enforcement policies as part of their COVID-19 economic stimulus and recovery packages. This approach is unwise and short-sighted as it provides very limited – if any – emergency economic stimulus and undermines commitments on climate change, nature conservation, and the protection of public health, and undermines future nature-based tourism development or recovery.
- **Maintain political space and rights for civil society and the press to serve an effective transparency and monitoring function regarding recovery and stimulus policies.** Some governments have used the pandemic as a pretext to suppress rights of free expression and political action. While political systems differ across the G20, responsible governments must avoid this tendency and should unite in discouraging such measures by other governments.
- **Provide income support to reduce the risk of poverty-induced encroachment into nature.** Governments should ensure that safety nets are in place, through social protection schemes (including cash and voucher transfers) targeting the poorest and most vulnerable to food and nutrition insecurity – reducing the need for these populations to rely on forests and other natural ecosystems and wildlife for their food security or livelihoods.
- **Attach green conditionalities to corporate bailouts, especially for sectors with a high impact on nature.** Relevant policy areas include company bailouts, stimulus incentives (e.g., taxation, subsidy and tariffs), regulation of capital markets, infrastructure investments, and policy and investment priorities for multilateral development banks.
- **Systematically apply spatial planning across land- and seascapes to harmonize nature protection with sustainable economic development.** To be effective, spatial planning needs to engage communities, business, local government and other stakeholders, be based on the best available science and data, and take place within a clear legal framework that ensures that the process is transparent and that there are accountability mechanisms in place to monitor outcomes.
- **Repurpose subsidies and other public support towards activities that conserve nature and incentivize nature-based solutions to post-pandemic economic recovery and restructuring.** Of more than $700 billion paid in agricultural subsidies each year, only 15% of this support goes towards building public goods. Similarly, $30 billion of public support is poorly targeted at fisheries, with around $22 billion of this classified as harmful. Such subsidy regimes undermine natural capital stocks, endangering biodiversity, long-term job stability and livelihoods as well as local and global ecosystem services.
- **Invest in innovative technologies that will enable more efficient and effective conservation and sustainable use of natural resources.** Recent technological advances now enable near-real time remote monitoring of land use changes to detect and prevent illegal deforestation and encroachment, illegal fishing, mining and other harmful activities as well as assist with spatial planning. Materials identification (e.g. DNA, stable isotope analysis) and supply chain logistics technology advances now allow for robust systems to make supply chains more transparent and to enable easier detection of violations and anomalies.
- **Create an enabling policy environment for private sector investment and innovation, including promotion of market mechanisms as a way to finance nature-based solutions.** We are already seeing a significant growth in the interest of private actors in financing "green" and "blue" carbon and other ecosystem services in forests, peatlands, mangroves and other natural ecosystems. These markets have the potential to scale to billions of dollars of financing for nature over the coming decade.
- **Invest in human capital, especially young people, to develop the skills and entrepreneurial mindset required to seize opportunities related to a nature-positive economy.** The world young people faced just a year ago was already changing at an unprecedented rate. The pandemic has radically accelerated the pace and direction of change. This young generation will need a substantially new set of skills to confront and adapt to a post-COVID word already reeling from climate change and biodiversity loss.

- **Mobilize enhanced public international development cooperation to support a just and sustainable economic recovery.** Wealthier "donor countries" are currently preoccupied with their own battle against the coronavirus and its economic impacts, but they should not allow the present crisis to compromise the need for sustained international development assistance to poorer countries who are also grappling with this on top of other long-term challenges. This is not only the right thing to do; it is also in everyone's self-interest, including those in wealthier nations, in our globally interdependent world.

Sources: WEF 2020c; Seymour et al. 2020; Levy et al. 2020.

Endnotes

1 Organizations that have endorsed the Apex Goal include WWF (organizer), World Resources Institute, the Wildlife Conservation Society, the World Business Council for Sustainable Development, The Nature Conservancy, the Potsdam Institute for Climate Impact Research, Luc Hoffmann Institute, the Global Environment Facility, Conservation International, the Capitals Coalition, Birdlife International, the Yellowstone to Yukon Conservation Initiative and 4SD.

2 This report adopts the IUCN definition of nature based solutions: “Nature-based solutions are actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits” (IUCN 2020b).

3 By focusing in this report on forests and coastal ecosystems as high global priorities, we do not mean to downplay the critical importance of other natural ecosystems for climate mitigation and adaptation, biodiversity conservation, and sustainable development in specific regional and country contexts, including tropical peatlands, grasslands, drylands, montane ecosystems, and the high seas.

4 Numbers represent reservoir mass, also called carbon stocks in PgC (1 PgC = 1015 gC) and annual carbon exchange fluxes (in PgC yr–1). Black numbers and arrows indicate reservoir mass and exchange fluxes estimated for the time prior to the Industrial Era, about 1750. The sediment storage is a sum of 150 PgC of the organic carbon in the mixed layer and 1600 PgC of the deep-sea $CaCO_3$ sediments available to neutralize fossil fuel CO_2. Red arrows and numbers indicate annual anthropogenic fluxes averaged over the 2000–2009 time period. These fluxes are a perturbation of the carbon cycle during the Industrial Era post-1750.

5 The mitigation significance of the living biomass carbon in tropical primary forests (104-118 Pg C) is highlighted by the fact that this is 91-103% of the remaining carbon budget of the ~114 Pg C required to attain a 66% probability of limiting global warming to 1.5 °C above pre-industrial levels (IPCC 2019).

6 Ninety percent of proposed new roads are in developing countries, including 7,500 km of new highways proposed in the Brazilian Amazon, 50,000 km of new logging roads proposed in the Congo basin, new roads opening up the last primary forests in Sumatra, the Panama-Colombia Highway threatening the Darien Wilderness, and many roads now bisecting protected areas (Laurance *et al*. 2014; Dulac 2013).

7 Mangroves, seagrass beds, and salt marshes are collectively termed blue carbon ecosystems for purposes of this report.

8 Existing protected areas are expanded to account for additional lands requiring increased conservation attention, augmented by additional climate stabilization areas and connected by potential wildlife and climate corridors. Numbers in parentheses show the percentage of total land area of Earth contributed by each set of layers. Indigenous lands are not shown but overlap extensively with proposed areas for increased conservation attention.

9 Article 6.8 of the Paris Agreement states that “Parties recognize the importance of integrated, holistic and balanced non-market approaches being available to Parties to assist in the implementation of their nationally determined contributions, in the context of sustainable development and poverty eradication, in a coordinated and effective manner, including through, *inter alia*, mitigation, adaptation, finance, technology transfer and capacity building, as appropriate. These approaches shall aim to . . . (c) Enable opportunities for coordination across instruments and relevant institutional arrangements.

10 Many of the Aichi targets were also integrated into the Sustainable Development Goals agreed by the UN in 2015, with end dates mostly moved to 2030.

References

Ajani, J.I. et al., 2013. “Comprehensive Carbon Stock and Flow Accounting: A National Framework to Support Climate Change Mitigation Policy.” *Ecological Economics* 89: 61–72.

Allen, T. et al., 2017. “Global Hotspots and Correlates of Emerging Zoonotic Diseases.” *Nature Communications* 8 Article 1124.

Anderson, C.M., et al., 2019. “Natural Climate Solutions Are Not Enough.” *Science* 363 (6430): 933–34.

Asner, G.P., et al., 2010. “High-Resolution Forest Carbon Stocks and Emissions in the Amazon.” *Proceedings of the National Academy of Science USA* 107 (38): 16738–16742.

Atwood, T.B., et al., 2020. “Global Patterns in Marine Sediment Carbon Stocks”. *Frontiers in Marine Science* Volume 7 Article 155.

Baldwin, R.F. et al., 2018. “The Future of Landscape Conservation.” *Bioscience*. 68(2), 60-63.

Bell, L. 2014. What is a peat swamp, and why should I care? Mongabay. July 20.

Brondizio, E.S. et al. (eds.) 2019. *Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Bonn, Germany: Intergovernmental Panel on Biodiversity and Ecosystem Services.

Buchwald, E. 2005. “A Hierarchical Terminology for More or Less Natural Forests in Relation to Sustainable Management and Biodiversity Conservation.” Meeting Report: Third Expert Meeting on Harmonizing Forest-Related Definitions. Danish Forest and Nature Agency.

Bunting, P., 2018. “The Global Mangrove Watch—A New 2010 Baseline of Mangrove Extent.” *Remote Sensing* 10: 1669.

Burke, L., et al. 2011. *Reefs at Risk Revisited*. Washington, DC: World Resources Institute.

Castanho, A., et al., 2016. “Changing Amazon Biomass and the Role of Atmospheric CO_2 Concentration, Climate and Land Use.” *Global Biogeochemical Cycles* 30: 18–39.

Caufield, C. 1984. *In the Rainforest. Report from a Strange, Beautiful, Imperiled World*. Chicago: University of Chicago Press.

CBD (Convention on Biological Diversity). 2009. *Connecting Biodiversity and Climate. Change Mitigation and Adaptation*. Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change. CBD Technical Series No. 41. Montreal, CA. CBD.

Ceballos, G. *et al*., 2020. Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. *PNAS*. June 1.

Clais, F. et al., 2013. “Carbon and Other Biogeochemical Cycles”. In: IPCC, 2013. *Climate Change 2013: The Physical Science Basis*. (Stocker, T.F. et al., eds.) Cambridge, UK: Cambridge University Press.

Coady, D. et al., 2019. *Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates*. International Monetary Fund Working Paper.

Coetzee, B.W.T. 2014. “Local Scale Comparisons of Biodiversity as a Test for Global Protected Area Ecological Performance: A Meta-Analysis”. *PLOS One* 9(8).

Cook, J. and R. Taylor. 2020. *Nature is An Economic Winner for COVID-19 Recovery*. Washington DC: World Resources Institute.

Cook-Patton, S.C. et al. 2020. “Mapping carbon accumulation potential from global natural forest growth.” *Nature* 585: 545-564.

Coral Reef Alliance. 2020. “Coral Reef Biodiversity.” Webpage. Accessed August 7, 2020.

Crooks, K.R. and M. Sanjayan (eds). *Connectivity Conservation*. Cambridge, UK: Cambridge University Press.

Curtis, P.G., et al. 2018. “Classifying Drivers of Global Forest Loss.” *Science* 361: 1108–1111.

Dasgupta, P., et al. 2020. *The Dasgupta Review – Independent Review of the Economics of Biodiversity*. Interim Report. HM Treasury, London, UK. April.

de los Santos, C.B., et al. 2019. “Recent Trend Reversal for Declining European Seagrass Meadows.” *Nature Communications* 10 (3356).

Diazgranados, M.C., and J. Howard. 2019. “Mangroves.” In: Kormos *et al*. 2019.

Dinerstein, E., et al. 2017. “An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm.” *BioScience* 67 (6): 534–545.

Dinerstein, E., et al. “A ‘Global Safety Net’ to Reverse Biodiversity Loss and Stabilize the Earth’s Climate.” *Science Advances* 6 (36).

Ding, H. et al., 2016. *Climate Benefits, Tenure Costs*. Washington DC: World Resources Institute. October.

Donohue, R.J., et al. 2013. “Impact of CO_2 Fertilization on Maximum Foliage Cover across the Globe’s Warm, Arid Environments.” *Geophysical Research Letters* 40 (12): 3031–3035.

Duarte, C.M., et al. 2008. “The Charisma of Coastal Ecosystems: Addressing the Imbalance.” *Estuaries and Coasts* 31 (2): 233–38.

Dulac, J. 2013. *Global Land Transport Infrastructure Requirements*. International Energy Agency.

Ellis, E.C., et al., 2010. “Anthropogenic Transformation of the Biomes, 1700 to 2000.” *Global Ecology and Biogeography* 19 (5): 589–606.

Ellis, P.W., 2019. “Reduced-Impact Logging for Climate Change Mitigation (RIL_C) Can Halve Selective Logging Emissions from Tropical Forests.” *Forest Ecology and Management* 438: 255–266.

Erb, K.H., et al., 2018. “Unexpectedly Large Impact of Forest Management and Grazing on Global Vegetation Biomass.” *Nature* 553: 73–76.

Evans, T. *et al*., 2020. *Links between ecological integrity, emerging infectious diseases originating from wildlife, and other aspects of human health - an overview of the literature*. Wildlife Conservation Society.

FAO. 2018. “Global Forest Resources Assessment 2020. Terms and Definitions FRA 2020.” Food and Agriculture Organization. Forest Resources Working Paper 188. Rome: FAO.

Frechette, A. et al., 2018. *A Global Baseline of Carbon Storage in Collective Lands. Indigenous and Local Community Contributions to Climate Change Mitigation*. Rights and Resources Initiative. September.

Funk, J.M., 2019. “Securing the Climate Benefits of Stable Forests.” *Climate Policy* 19(7), 845-860.

G20 2020. Extraordinary G20 Leaders' Summit Statement on COVID-19. March 26.

Gaubert, B., 2019. "Global Atmospheric CO_2 Inverse Models Converging on Neutral Tropical Land Exchange, but Disagreeing on Fossil Fuel and Atmospheric Growth Rate." *Biogeosciences* 16: 117–134.

GCA (Global Commission on Adaptation). 2019. *Adapt Now: A Call for Global Leadership on Climate Resilience*. September.

Grace, J., et al. 2014. "Perturbations in the Carbon Budget in the Tropics." *Global Change Biology* 20: 3238–3255.

Griscom, B.W., 2017. "Nature Climate Solutions." *Proceedings of the National Academy of Sciences* 114 (44): 11645–11650.

Griscom et al., 2019. "Natural climate solutions". *PNAS* 14(44).

Gritten, D., 2018. *Community Forestry and Forest Landscape Restoration: Attracting Sustainable Investments for Restoring Degraded Land in Southeast Asia*. RECOFTC.

Haddad, N.M., et al.2015. "Habitat Fragmentation and Its Lasting Impact on Earth's Ecosystems." *Science Advances*. 1:e1500052.

Harris, N. et al. 2020. "Young Forests Capture Carbon Quicker than Previously Thought." World Resources Institute. September 23.

Heron, S.F., 2017. *Impact of Climate Change on World Heritage Coral Reefs. A First Global Scientific Assessment*. UNESCO.

Hoare, A. 2020. *Forest Governance and Deforestation: Exploring the Disparity*. Chatham House. March 3.

Hoegh-Guldberg, O., 2019. *The Ocean as a Solution to Climate Change: Five Opportunities for Action*. Washington, DC: World Resources Institute.

Howard, J., and E. Pidgeon. 2019. "Oceans." In Kormos et al. 2019.

Ibisch, P.L., et al. 2017. "A Global Map of Roadless Areas and Their Conservation Status." *Science* 354 (6318): 1423–1427.

IPCC. 2018. "Summary for Policymakers." In *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*, V. Masson-Delmotte et al. (eds.)

IPCC. 2019. Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems, P.R. Shukla et al. (eds.)

IUCN. 2020a. IUCN Policy Statement on Primary Forests Including Intact Forest Landscapes. January.

IUCN 2020b. *Global Standard for Nature-based Solutions*. July.

Keith, H. et al, 2009. "Estimating Carbon Carrying Capacity in Natural Forest Ecosystems across Heterogeneous Landscapes: Addressing Sources of Error." *Global Change Biology* 16: 2971–2989.

Köhl et al., 2017. "The impact of tree age on biomass growth and carbon accumulation capacity: A retrospective analysis using tree ring data of three tropical tree species grown in natural forests of Suriname." *PLOS One* 12(8). August 16.

Kormos, C.F. et al. 2019. *Nature's Solutions to Climate Change*. CEMEX Corporation, Monterrey, Mexico.

Körner 2017. "A matter of tree longevity". *Science* 355(6321) 130-131. January 13.

KSA (Kingdom of Saudi Arabia). 2019. *Overview of Saudi Arabia's 2020 G20 Presidency: Realizing Opportunities of the 21st Century for All*. December.

Laurance, W.F. et al., 2014. "A global strategy for road building". *Nature* 513 229-232. August 27.

La Vina, A.G.M., and A. de Leon. 2017. "Conserving and Enhancing Sinks and Reservoirs of Greenhouse Gasses, Including Forests (Article 5)." In D. Klein et al. (eds.) *The Paris Agreement on Climate Change: Analysis and Commentary*. Oxford University Press.

Landler, M. and J. Perlez 2016. "Rare Harmony as China and U.S. Commit to Climate Deal." New York Times. September 3.

Lee, S.Y., 2019. "Better Restoration Policies Are Needed to Conserve Mangrove Ecosystems." *Nature Ecology & Evolution* 3 (6): 870.

Levy, J. *et al*. 2020. *Designing the COVID-19 Recovery for a Safer and More Resilient World*. World Resources Institute. May.

Lewis, S. et al., 2009. "Increasing Carbon Storage in Intact African Tropical Forests". *Nature* 457(7232) 1003-6.

Lewis, S.L. 2019. "Restoring natural forests is the best way to remove atmospheric carbon". *Nature* 568. 4 April.

Lindsey, R. 2020. *Catastrophic wildfires in southeastern Australia in 2019-20*. U.S. National Oceanic and Atmospheric Administration (NOAA).

Lovejoy, Thomas E., and C. Nobre. 2019. "Amazon Tipping Point: Last Chance for Action." *Science Advances* 5 (12): eaba2949.

Mackey, B. I., et al.2013. "Untangling the Confusion around Land Carbon Science and Climate Change Mitigation Policy." *Nature Climate Change* 3 (6): 552–57.

Mackey, B.I., 2015. "Policy Options for the World's Primary Forests in Multilateral Environmental Agreements: Policy Options for the World's Primary Forests." *Conservation Letters* 8 (2): 139–47.

Mackey, B.I., 2020. "Understanding the Importance of Primary Tropical Forest Protection as a Mitigation Strategy." *Mitigation and Adaptation Strategies for Global Change*, March.

MacKinnon, K. et al., 2019. "Nature-Based Solutions and Protected Areas to Improve Urban Biodiversity and Health". In: Marselle M.R. et al. 2019. *Biodiversity and Health in the Face of Climate Change*. Springer Link. pp 363-380.

Masiero, M., et al.2019. *Valuing Forest Ecosystem Services*. Rome: Food and Agriculture Organization of the United Nations.

McBride, J. and A. Chatzky 2020. *The Group of Twenty – Backgrounder*. Council on Foreign Relations.

Mcleod, E., 2011. "A Blueprint for Blue Carbon: Toward an Improved Understanding of the Role of Vegetated Coastal Habitats in Sequestering CO_2." *Frontiers in Ecology and the Environment* 9 (10): 552–60.

Mitchard, E.T.A. 2018. "The tropical forest carbon cycle and climate change". *Nature* 559 527-534. 25 July.

Moomaw, W.R. et al., 2019. "Intact Forests in the United States: Proforestation Mitigate Climate change and Serves the Greatest Good". *Frontiers in Forests and Global Change* 2(27).

Naidoo, R. et al., 2019. "Evaluating the impacts of protected areas on human well-being across the developing world". *Science Advances* 5(4). April 3.

Nasi, R. 2019. “Peatlands.” In Kormos et al. 2019.

Navarrete-Segueda, A. et al., 2018. “Variation of main terrestrial carbon stocks at the landscape-scale are shaped by soil in a tropical rainforest”. *Geoderma* 313: 57-68.

Nellemann, C., 2009. *Blue Carbon. A Rapid Response Assessment.* United Nations Environment Programme, GRID-Arendal 78.

Nemani, R.R. et al., 2003. “Climate-driven increases in global terrestrial net primary production from 1982 to 1999”. *Science* 300(5625) 1560-3. June 6.

NYDF Assessment Partners. 2019. *Protecting and Restoring Forests: A Story of Large Commitments yet Limited Progress. New York Declaration on Forests Five-Year Assessment Report*. Climate Focus.

OECD (Organization for Economic Cooperation and Development) 2019. Agricultural Policy Monitoring and Evaluation 2019. Paris.

Palmer, M.A. and C.M. Febria. 212. “The Heartbeat of Ecosystems”. *Science* 336(6087).

Pan, Y. et al., 2011. “A Large and Persistent Carbon Sink in the World’s Forests”. *Science* 33(6405) 988-993.

Parrish, J.D. et al., 2003. “Are We Conserving What We Say We Are? Measuring Ecological Integrity within Protected Areas”. *BioScience* 53(9). September.

Pecl, G.T. et al. 2017. “Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being”. *Science* 355(6332).

Pharo, P. et al., 2019. *Growing Better: Ten Critical Transitions to Transform Food and Land Use*. Food and Land Use Coalition.

Pidgeon, E. 2019. “Seagrasses.” In Kormos et al. 2019.

Pierre-Louis, K. 2019. “The Amazon, Siberia, Indonesia: A World of Fire.” *New York Times*. September 4.

Plowright, R.K. et al., In Review. “Landscape immunology: Understanding land use influences on zoonotic spillover and public health.”

Potapov, P. et al., 2017. “The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013”. *Science Advances* 3(1). January 13.

Puettmann, K.J. et al. 2015. “Silvicultural alternatives to conventional even-aged forest management – what limits global adoption?”. *Forest Ecosystems* 2(8).

Quinney, M. 2020. *COVID-19 and nature are linked. So should be the recovery.* World Economic Forum. April.

Ramos, J. 2019. “Tidal Saltmarshes.” In Kormos et al. 2019.

Randers, J., 2018. *Transformation Is Feasible. How to achieve the Sustainable Development Goals within Planetary Boundaries*. A report to the Club of Rome for its 50 years anniversary 17 October 2018. Stockholm Resilience Centre.

Reid, W.V. et al. 2005. *Ecosystems and Human Well-Being.* Millennium Ecosystem Assessment. Washington, DC: Island Press.

Rockstrom, J. 2009. “Planetary Boundaries: Exploring the Safe Operating Space for Humanity.” *Ecology and Society* 14 (2): 32.

Rocliffe, S. et al. 2014. “Towards a Network of Locally Managed Marine Areas (LMMAs) in the Western Indian Ocean”. *PLOS One* (9)7. July 23.

Romanach, S. et al.2018. “Conservation and Restoration of Mangroves: Global Status, Perspectives and Prognosis.” *Ocean & Coastal Management* 154: 72–82.

Schmidt-Traub, G. 2020. “Integrating Climate, Biodiversity and Sustainable Land Use Strategies: Innovations from China.” *National Science Review.* Nwaa139.

Schuster, R. et al. 2019. “Vertebrate biodiversity on indigenous-managed lands in Australia, Brazil, and Canada equals that in protected areas”. *Environmental Science & Policy* 101, 1-6.

Searchinger, T., 2008. “Use of U.S. Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land-Use Change.” *Science* 319 (5867): 1238–40.

Seddon, N. et al., 2020. “Understanding the Value and Limits of Nature-Based Solutions to Climate Change and Other Global Challenges.” *Philosophical Transactions of the Royal Society B: Biological Sciences* 375 (1794): 20190120.

Settele, J. et al., 2020. “COVID-19 Stimulus Measures Must Save Lives, Protect Livelihoods, and Safeguard Nature to Reduce the Risk of Future Pandemics.” IPBES Expert Guest Article. April 27, 2020.

Seymour, F. *et al*. 2020. *Déjà vu: Anticipating the Impacts of Economic Crisis on Indonesia’s Forests*. World Resources Institute. Washington DC.

Seymour, F. and N. Harris. 2019. Reducing tropical deforestation. *Science* 365(6455), 756-757. August 23.

Sloan, S. et al., 2014. “Remaining natural vegetation in the global biodiversity hotspots”. *Biological Conservation* 177, 12-24.

Steffen, W. et al. 2015. “Planetary boundaries: Guiding human development on a changing planet”. *Science*. 347(6223). February 13.

Soubelet, H., 2020. “Covid-19 et biodiversité : vers une nouvelle forme de cohabitation entre les humains et l’ensemble des vivants non-humains.” *Biodiversité et Santé*. Avril.

Stevens, C., 2014. *Securing Rights, Combating Climate Change*. Washington, DC: World Resources Institute and the Rights and Resources Initiative.

UNEP (United Nations Environment Programme) 2018. “Stockholm + 50” – an opportunity to consider a new long-term vision for the global environmental agenda in the context of the 2030 Agenda.” Discussion Paper. Second Joint Retreat for the Bureaux of the UN Environment Assembly and the Committee of Permanent Representatives. Tallinn, Estonia. September 6–7.

Taubert, F. et al., 2018. “Global patterns of tropical forest fragmentation”. *Nature* 554, 519-522. February 14.

Turbanova et al., 2018. “Ongoing primary forest loss in Brazil, Democratic Republic of the Congo, and Indonesia”. *Environmental Research Letters*. 13 074028.

UNEP 2020. Working with the Environment to Protect People: UNEP’s COVID-19 Response.

United Nations. 2019. *The Nature-Based Solutions for Climate Manifesto.* Developed for the UN Climate Action Summit 2019 by NBS Track co-leads China and New Zealand.

Valiela, I. et al., 2001. “Mangrove Forests: One of the World’s Threatened Major Tropical Environments”. *BioScience* 51(10). October.

Veldman, J.W., 2015a. “Where Tree Planting and Forest Expansion Are Bad for Biodiversity and Ecosystem Services.” *BioScience* 65 (10): 1011–18.

Veldman, J.W., et al. 2015b. “Tyranny of Trees in Grassy Biomes.” *Science* 347 (6221): 484–85.

Venter, O. et al., 2016. “Sixteen years of change in the global terrestrial human footprint and implications for biodiversity conservation”. *Nature Communications* 7(12558). August 23.

Visconti, P., 2019. “Protected Area Targets Post-2020.” *Science* 19 364 (6437): 239–241.

Waldron *et al*., 2020. *Protecting 30% of the planet for nature: costs, benefits and economic implications*.

Warren, B. 2020. *"*G20 governance of climate change through nature-based solutions". *Global Solutions Journal*. Issue 5, 135-145.

Watson, J.E.M., *et al*. 2018a. "Protect the Last of the Wild." *Nature*. 563 (27): 27-30.

Watson, J.E.M., 2018b. "The Exceptional Value of Intact Forest Ecosystems." *Nature Ecology & Evolution* 2 (4): 599–610.

Waycott, M., 2009. "Accelerating Loss of Seagrasses across the Globe Threatens Coastal Ecosystems." *Proceedings of the National Academy of Sciences.* 106: 12377–81.

WEF (World Economic Forum) 2020a. *COVID-19 Risks Outlook – A Preliminary Mapping and Its Implications*. May.

WEF. 2020b. *Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy*. January.

WEF. 2020c. *The Future of Nature and Business Policy Companion. Recommendations for policy-makers to reset towards a new nature economy*. July. In collaboration with SYSTEMIQ.

WEF. 2020d. *The Global Risks Report 2020*.

Weisse, M. and E. Dow-Goldman. 2020. *These charts show what forest loss looks like across the globe*. World Economic Forum and World Resources Institute. June 11.

Weisse, M., and L. Goldman. 2020. *We Lost a Football Pitch of Primary Rainforest Every 6 Seconds in 2019*. Global Forest Watch, World Resources Institute.

Wilson, E.O. 2016. *Half Earth: Our Planet's Fight for Life*. New York: W.W. Norton.

Wood, S.L.R. et al. 2018. Distilling the Role of Ecosystem Services in the Sustainable Development Goals. *Ecosystem Services* 29 (February): 70–82.

Worboys, G. L. et al. (eds), 2010. *Connectivity Conservation Management: A Global Guide*. Earthscan.

WWF (World Wildlife Fund). 2020a. "Beyond Boundaries: Insights into Emerging Zoonotic Diseases, Nature, and Human Well-Being." Internal WWF Science Brief. May 6, 2020.

WWF. 2020b. *COVID-19. Urgent Call to Protect People and Nature*. June.

Xu, L. et al., 2017. "Spatial Distribution of Carbon Stored in Forests of the Democratic Republic of Congo". *Scientific Reports* 7, Article Number 15030. November 8.

Yudhoyono, S.B. 2009. Intervention by H.E. Dr. Susilo Bambang Yudhoyono, President of the Republic of Indonesia, on Climate Change. G20 Leaders' Summit, September 25, 2019, Pittsburgh, PA.

Zimmer, K. 2019. Researchers Find Flaws in High-Profile Study on Trees and Climate. *The Scientist*. October 17.

Zimmerman, B. et al., 2020. "Large Scale Forest Conservation With an Indigenous People in the Highly Threatened Southeastern Amazon of Brazil: The Kayapo". In: Goldstein, M. and D. DellaSala (eds), 2020. *Encyclopedia of the World's Biomes*. Elsevier.

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